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The Carnage of Peace.

A speaker at one of the recent peace conferences grimly intimated that if the bearers of the olive branch really want to preserve human life and prevent human suffering, they should turn their attention to the casualties of peace. This country, he said, could be in perpetual war with a smaller annual loss in killed and wounded than it now incurs from accidents upon trains and railways, more easily preventable than is the clash of arms. This so-called accident list exceeds in its awful yearly total the entire personnel of the combined army and navy of the United States. Were ten great battleships yearly to be sunk in action and every man aboard them lost, there would be fewer widows and orphans than must be reckoned on the blood-written score of the railways alone. Add to this the other casualties, from fire and water, from trains and automobiles, from falling buildings and wrecked mines, and the total rises to a figure truly appalling and the more dreadful because it is for the most part needless.

Moreover, the United States, peace-loving and foremost in the cause of arbitration, has won a bad pre-eminence in these tragedies. We live fast and recklessly and from daily habitude have become hardened to tales of death and disaster. One must realize, of course, that some accidents seem inevitable, not to be averted by any human foresight, yet the fact stares one in the face that European nations can and do prevent so terrible a ratio of disaster, particularly in means of transportation. Here is a field for beneficence that belongs peculiarly to the engineer, who is the mainstay of the works of civilization. Upon him rests, not the responsibility for the conditions that exist, but much of the technical work that may tend to remedy them. The real weight lies upon the civic and social conscience of mankind. If one looks over the list of the last catastrophes and inquires to whom the responsibility has been brought home, and who has paid the penalty of the evil he has wrought, the page of retribution is a ghastly blank. The stigma of negligence is shuffled dextrously out of sight and lost in the mazes of impersonal administration. The stern demand of justice is met shamelessly by the contemptuous question of Cain.

There needs to be an awakening of the sense of personal responsibility and of commercial duty in these things. Of what use is it to beat the sword, not into the ploughshare, but into the scythe of the reaper? A complex civilization brings with it dangers as well as benefits. There has never been a time in the world's history when benevolence has been so active along certain lines as now. Epidemics have been fought down and famine within the reach of modern transportation has been made well-nigh impossible. Yet with all this the spectres of those ruthlessly struck down on the field of peace rise in a mighty host to give benevolence the lie and to rebuke the pride of prosperity.

But what can the engineer do to check the dismal tide of disaster and to arouse his fellows to the task of making the piping times of peace less sanguinary than the days when armies are on the march? He who dares can do much, both personally and by example and precept. First of all, he can see to it that all the works with which he personally has to do are made safe and kept safe. To give human nature justice, most dangerous conditions are due more to negligence and lack of foresight than to cold-blooded and deliberate disregard of safety. The steady influence of the engineering profession thrown systematically in the office and in the field against taking chances would do an enormous amount of good. Much personal influence is already so thrown, but it is united and forceful action that counts. If it were generally understood that the engineering profession stood as a unit for safety devices and methods to the extent of making it difficult to find any one to tolerate improper methods, the day of reckless scamping and negligence would draw near its close.

This organized passive resistance, however, is not enough. It is high time that the profession, representing as it does expert knowledge and accurate judgment of those things which have to do with the dangerous contingencies of modern life, roused itself to active civic service, and joined the general movement against the powers of evil that override law and righteousness. If, for example, each great engineering body should appoint a Committee of Public Safety to co-operate with the existing bodies devoted to civic improvement, the result in preventing needless accidents would be enormous. A very few years of combined effort would cut down the yearly death roll to a far less terrible total. The private engineer can do little against the organized forces of cupidity and corruption. If he raises a voice of protest against menaces to human life in transportation or building or manufacture he is generally cursed as a Socialist, or denounced as an enemy of vested rights, or condemned as a traitor to our Better Classes. Concerted action, however, is quite another matter. He would be a bold man who would contemptuously disregard a formal notice of dangerous conditions served upon him by the Committee of Public Safety of, let us say, the American Society of Civil Engineers, acting in concurrence with the local Civic Federation or Law and Order League or whatever you please. Along another line the advice of engineering bodies in case of contemplated safety legislation would ensure a sound course of action and would check ill-advised and ineffective attempts often now made with the best intentions, but with small knowledge of wise methods. Such a committee would be, from professional conscientiousness, sufficiently conservative and would be a terror to evil doers. There are hundreds of engineers who would promptly report an unsafe culvert or a dangerous foundation if there were a body ready to investigate and act without drawing their informant into a long-winded personal controversy. There is a capital chance for valuable public service along this line with splendid results in the security of life and property. With the civic awakening now in progress sound methods if once pointed out can be very frequently enforced. It is a terrible arraignment of present conditions when one has to ask himself whether the "Peace of Dives" is worth its price.

The Sliding of Reservoir Banks.

The sliding of a wet bank of a reservoir wholly or partially filled is not an uncommon occurrence; in fact, so many reservoir banks have been subject to such an experience that slips of this nature are seldom regarded as very serious unless the safety of the bank is jeopardized. The latest occurrence of this kind, which has perhaps attracted a little more attention than usual, is the large slip of the inner face of the north dyke of the Wachusett reservoir, a complete description of which has already been published in this journal. Even this slip need not necessarily be regarded as prejudicing the integrity of the reservoir as a holder of water and certainly neither it nor any other similar experience in the past constitutes a substantial argument against earth dams properly designed and constructed, as is conclusively indicated by the number of satisfactory structures of that character which have been performing heavy duties efficiently for many years. On the other hand, all these partial failures of reservoir banks are of sufficient importance to require a searching examination and study so that such incidents in the future may be reduced to a minimum or, if possible, entirely avoided.

There are engineers, perhaps many of them, who in discussions of the matter express confidence in what may be called sand dams, and even go so far occasionally as to state specifically that such dams may be depended upon for retaining considerable depths of water. This judgment is usually based upon the undoubted fact that sand banks retaining water carrying more or less silty material are frequently silted practically tight. While such embankments permit substantial amounts of water to pass through them at first, the small particles of silty material carried into the interstitial spaces of the sand eventually close them so as to produce a tight bank or one practically so. This experience is not unusual; it is well known to be the sequence of results in many places, but it should not be made the basis of too general conclusions.

There can be no very extended experience with the conditions of maintenance attending banks of permeable material without a sufficient number of prejudicial results of one kind or another to give a clear impression that, in the long run, an impermeable reservoir bank is to be preferred over one through which the water may seep or percolate. There are many cases, in both artificial banks and natural masses of sand and gravel, in which the finely diffused percolation between the sand grains, instead of being obstructed by gradual silting, will make for itself slightly enlarged channels at points, and sometimes many points, by moving out the fine grains from among those that are coarser. This action may take place with water carrying substantial amounts of silty material. The result of these conditions is the gradual formation of interior channels among the coarser grains of the mass, which, while usually small, are capable of discharging in the aggregate substantial volumes of water. In some cases a network of such small underground channels will discharge comparatively large aggregate volumes of water, as shown by many natural abundantly flowing springs.

Where such pervious material may afford water passages through an embankment its failure is almost certain to take place eventually. On the other hand, where such pervious material is backed by an impervious mass the former simply becomes completely saturated as the water rises in the reservoir. When it is remembered that many fine sands, even, will afford void spaces from 30 to 45 per cent. of the total volume, the amount of water finding its way into a permeable bank is at once seen to be great enough to produce a radical difference in the condition from that existing in the dry bank. In addition to this, when it is remembered that many of these interstitial spaces are small enough to produce an intense capillary effect, separating and loosening much of the mass, it is apparent why most banks of sand taking the natural slope when dry should flow down to a far flatter slope when wet. This latter action is one which does not always receive the attention its importance demands, especially if the bank when made is paved in its upper portions to guard against the wash of waves. Such a pavement is much heavier than the dry sand on which it is originally placed. After the completion of the work, when the reservoir is either partially or wholly filled, the saturated sand will assume under water a greatly reduced slope and thus withdraw the support which the dry material had given to the pavement. This effect will sometimes take place with the paving extending to the toe of the bank. Even when the paved slope is effectually supported at its lower edge, the sand backing under the action of the water may flow out through the open joints and leave the broken slopes so frequently observed under such circumstances.

A well solidified bank of impervious material presents no such conditions inducing motion of its face as those sure to arise in a saturated mass. While it is true that water will find its way to some extent into a so-called impermeable material, the interstitial spaces are exceedingly small and the penetration is so greatly retarded as to reduce its action to almost nothing. Further than this, there is measurable cohesion between the grains composing the material which is almost or quite absent in sand or a mass in which sand constitutes the greater part. The one lesson which these slips teach with the conclusive force of actual failure is that an impermeable mass of material into which it is practically impossible for the water to enter will be free from the hazardous results made imminent by a comparatively free saturation, even though there are some conditions in which the use of permeable material does not lead to a collapse.

Institutional Power Plant Problems.

The handling of institutional power-plant problems requires such special treatment from the consulting engineer in respect to design and construction that the broad differences between commercial and public or quasi-public practice must be fully appreciated if an engineering job of this kind is to be profitable to the advisory expert and thoroughly satisfactory to the clients. In regard to both policy and technical details the engines must be prepared to proceed upon an entirely different basis than would govern his course of action in an ordinary commercial installation. Failure to apprehend the difference in conditions may carry a heavy penalty in the form of injured professional reputation, to say nothing of the obliteration of profits through long delayed settlement of accounts and claims that the work does not satisfy each detail of the owner's desires.

Subdivided authority is one of the most troublesome features likely to occur in institutional power-plant practice. Desirable as it is that the work of the advisory engineer, his plans, specifications and inspection, shall be in general charge of a single competent official, it is frequently the case that the advantages of reporting to a single executive cannot be enjoyed; but the work must be subject to the beck and call of a board of trustees, many of whom lack the slightest knowledge of engineering practice and cannot be persuaded of the wisdom of policies involving larger first cost and ultimate greater economy of operation, without the most tactful and definite elementary explanations and figures based on demonstrable facts. While these considerations obtain to some extent in all consulting practice, it is a peculiar essential of institutional power plant work that the advisory engineer shall be prepared to enter in greater detail into his reasons for all technical recommendations. In the design and construction of a large, recently completed institutional plant this need was so fully realized by the engineers that the office was specially organized to record the reasons for the choice of every piece of apparatus installed, the original and final recommendations of the engineers, causes of change in layout, opinions of the institution authorities, quotations received from competing manufacturers and contractors, and the dates of beginning, progress and completion of all essential parts of the work. Interviews with other experts and the summary of important letters were all filed according to subject, and the detailed calculations of the heating system, the power and light wiring, determination of desirable sizes of equipment and such data, were likewise classified for reference.

The expense of a campaign of this kind was naturally heavy, but the magnitude of the job and the importance of being able at all times to meet the criticism and objections of the trustees with broader information than mere opinions justified the outlay in time and clerical effort. In many lines of commercial practice the mere opinion of a qualified expert is often sufficient; if it is backed by a few cogent arguments the weight of the recommendation may carry all before it in destroying the opposition of a busy executive, but in institutional work the need of detailed arguments is generally much more insistent. In addition to the construction drawings made for the contractors' use in the case of the plant mentioned above, blueprints were prepared showing the general location of all machinery in plan and elevation. Such "picture plans," so-called, are specially needed in power-plant designs for institution service, and without them much time is liable to be lost in securing the approval of governing boards to any extensive schemes of apparatus arrangement.

Local conditions obviously determine the extent to which practice like the foregoing shall be adopted, and in all cases there should be a charge on the part of consulting engineers ample in amount to cover the cost of the special treatment needed. A definite understanding in advance regarding the persons authorized to receive blueprints on behalf of the institution is a point well worth securing. It is certainly fair that any firm of engineers which is obliged to consume a considerable amount of time and office labor in educating its clients to appreciate the close points of reasoning in recommendations and suggested plans should be adequately compensated for the efforts expended.

On its technical side the institutional power plant affords the opportunity for no little finesse in design and construction. The tendency in such installations is inevitably toward high first cost, especially in public services. Architectural features receive more consideration from the owners, and there is a far-reaching tendency toward the installation of specialties which may or may not increase the flexibility and reliability of the service. The soundest engineering judgment is essential in such work, for the requisites of moderate cost of operation and maintenance and a reasonable investment for the installation furnished are as desirable in the interest of first-class institutional practice as in the highly competitive commercial installation. The owners of an institutional plant may elect to install a more costly system than is advisabe from the mere standpoint of engineering, but it is the part of the consulting expert to see that the owners do this with their eyes open. Now and then a private plant is built by an owner to whom cost is entirely a secondary consideration, and fortunate is the engineer with such a client, provided the distinction between what is right for the work and the best which money can buy is clearly understood by the client himself. The engineer's duty ceases when his opinion and supervision have been accorded on the basis of the best known practice of his time, modified, if the client so desires, to meet peculiar conditions of service.

A Novel Rolling Mill Drive.

The application of electric power in rolling mills is no new thing, but it has been left for the works at Trzyneitz (advocates of simplified spelling please note) to carry the plan to its legitimate conclusion. The weak point in ordinary electrical driving is the enormous output momentarily required in a set of rolls, coupled with the regular necessity of reversing. To provide overload capacity enough in the motors and generators is almost out of the question, so that the utilization of flywheel capacity is almost a necessity. The plant under consideration is operated by a very ingenious modification of the well-known Ward Leonard system, the starting generators being directly driven by a 2,500-h.-p. induction motor with two 26-ton flywheels, and feeding three drive motors mechanically coupled and connected in series. By this arrangement the flywheels back up the drive without themselves requiring reversal. The flywheels are brought into action by increasing the slip of the main motor by inserting resistance. A small auxiliary motor with its armature in series with the main motor and counterbalanced cuts in resistance and throws the burden on the flywheels whenever the input increases beyond a predetermined amount. About 1,000 h.-p. steady input thus takes care of momentary calls for as much as 10,000 h.-p. The arrangement seems to be admirably effective and deserves to be followed in this country, as it is already being followed abroad. There are many cases in which gas engines operated by blast furnace gases can furnish very cheap power for rolling mills. A drive of this kind seems pe culiarly adapted to such conditions, since it equalizes the load extremely well, so as to give the fairly uniform output desirable for gas engines. The method adopted in this plant is certainly a step in advance in this especially strenuous class of work.

Railway Bullyragging and Engineering Prospects.

A number of months ago it was pointed out that the business situation in the United States was extremely satisfactory, and the only danger sign was possible legislation against the best interest of the people. Legislation of this sort has very rapidly become prevalent, unfortunately, and it is desirable to point out its possible effect on engineering work. It centers mainly about the railroad companies of the country. These companies have faults; some of them have committed grave blunders in their dealings with the public. Unquestionably many defects of the present situation can be remedied by suitable legislation, but the menace of hard times which now threatens the country is that of entirely inappropriate legislation, which will destroy instead of remedying. A large proportion of our people depend more or less directly upon the efficiency of methods of transportation for obtaining the best results from their labor. Anything which tends to decrease this efficiency is prejudicial to the interest of the country. Anything which makes it impracticable for railroad companies to give as good service as they are furnishing now will react on most readers of this journal, and for this reason it is time for them to give thoughtful consideration to the problem which is now arising. Many readers not directly connected with railways will find that the unreasonable legislation passed in numerous States will interfere with their business interests if it is not modified. If this legislation meant an improvement in the general public condition, there would be small ground for any complaint, even if temporary inconvenience resulted, but it seems to mean a general depreciation of the prosperity which is rightfully ours at the present time, and for this reason is to be deplored.

It is manifest that anything which interferes with the operation and extension of railways will directly affect those employed by them, but this injurious effect will extend to an enormous number of people not associated directly with transportation companies. For example, a petition signed by manufacturers in the railway supply trade, representing 225,000 employes, who number, with their families, close to a million people, indicates very well what is already happening in one great industry. As a result of the four hundred bills now pending in State legislatures or recently passed by them, and the ordinances which city and town authorities are considering, an enormous amount of proposed railway construction has been stopped for the time being. As a result the companies manufacturing supplies for railway purposes, the support of about a million people, are without an assurance of work for the next year. At present business is good on old orders, but it is believed that business will be extremely bad unless this anti-railway agitation is stopped. Not only does this agitation threaten to throw out of employment a large number of skilled men paid high wages, but it accomplishes nothing whatever which is of any use to the community. No railway company can handle freight and passengers at less than cost for a very long time. The result will either be the bankruptcy of the railway companies or else a tremendous deterioration in the nature of the service rendered. If legislatures compel companies to accept low fares, the people must expect to get the equivalent grade of transportation, and what the country needs at the present time is better and not worse facilities. Many of the rate bills passed in the last twelve months are admirable examples of how to kill the goose that lays the golden egg.

At present railway companies in many sections of the country find it extremely difficult to handle all the traffic presented to them. They are in pressing need of more rolling stock, more tracks, larger yards and other facilities for caring properly for the great volume of business which the country's natural prosperity furnishes. Instead of helping the companies to obtain these facilities, it is now the legislatures' hobby to prevent them in the most effective manner from securing the financial aid needed to carry out their plans. None of these companies possess the money necessary for improving their present facilities. They must borrow this money exactly as an individual does, and if anything affects their credit so that they cannot obtain loans then improvements are impossible. Nothing can more seriously affect the credit of a company than hostile legislation, and no legislation can be more hostile than that which is aimed directly at the financial management of a company. There is a great deal to be said in favor of the better control of interstate commerce, but State interference with short-distance traffic is a matter which must be considered very carefully indeed.

The effect of many of the rate laws which have gone into force or are proposed in numerous States will be to check very largely industrial enterprises, for tariffs based on distance of traffic are directly contrary to the teachings of American experience. Our railways have been of great service to the development of the country because they have largely disregarded distance in making rates, and have based their charges more nearly on the actual cost of transportation. As a result our freight charges are an extremely small fraction of what they are in most other countries, even for short distances, while for long distances our charges are so small as to seem incomprehensible to a foreign railway official. If this system is thrown overboard for one based solely on distance, as is now the legislative practice, the result will be to raise prices materially on all commodities not obtained in the immediate vicinity of the purchaser. It will not only be more difficult to get goods under conditions which throttle railway service, but they will cost more, and in consequence the volume of purchases will be reduced. The final consequence, therefore, will be a reduced demand for all kinds of products and hence a diminution in the demand for engineering services.

This journal believes that there are many things which need reform in connection with railway affairs, but it has no sympathy with the kind of reform which is based on a lack of appreciation of facts and shows an entire disregard for the consequences of ill-considered legislation. Engineers owe a duty to the public in matters of this sort; they should not hesitate to use their influence so far as possible to check this spread of pernicious legislation which does no good and threatens seriously the continued business prosperity of the country. This journal does not anticipate that any very serious outcome will result from the present flurry of adverse legislation, for it has sufficient confidence in the inherent desire of legislatures to serve the public welfare to believe that the present conditions are merely a spasm brought about by temporary conditions and likely to be forgotten as soon as matters are seen in their true light. While the condition is serious to-day, it probably will not remain serious long, and energetic missionary work by engineers will do much to eradicate this malady promptly.

THE NEW PARKWAY IN PHILADELPHIA is naturally attracting a great deal of attention from the leading citizens of that place, for it is a decidedly ambitious project to provide in the heart of a large city a boulevard comparable in every respect with those of Paris. The proposed line of the parkway is from the City Hall in a straight line to the reservoir in Fairmount Park. The present plans are quite different from the project first outlined as far back as 1878. Fifteen years ago, when the present governor of Pennsylvania was mayor of Philadelphia, the idea was to have a boulevard much less than 200 ft. in width, but nothing was done about that suggestion for a number of years, and it was not until 1901 that a proposal for a parkway 300 ft. wide was strongly advocated. Under the energetic leadership of Mr. John H. Converse, the parkway project has lately been pushed forward vigorously, and it is now certain that a handsome avenue will be constructed along the line mentioned. It is not yet known, however, whether the consent of the Legislature can be obtained for privileges similar to those granted by the Ohio legislature to the city of Cleveland when the latter sought powers to construct its Court of Honor, now about half built. The Ohio city received authority from the legislature to condemn a wide strip of land along the parkway which could later be sold, thus securing control of all the buildings constructed along the improvement.

WM. J. JOHNSTON, whose death last Sunday is announced elsewhere in this journal, was one of the leading figures of American class journalism for many years. It is hard for many familiar with the extraordinary range of trade journalism at the present time to appreciate all the difficulties he encountered when he first took up this work. He was a telegraph operator in the service of the Western Union Telegraph Co. and that organization gave him the choice between staying in its service or else embarking for himself on the publication of a little paper for telegraph and electrical interests. He chose the latter alternative and with a capital of $100 and an unbounded faith in the future of class journalism took up the work which he subsequently followed so successfully and with such advantage to many readers and several great industries. For two reasons he will long be remembered by those engaged in similar work. In the first place, he absolutely divorced his editorial and business departments. He recognized that subscribers of the best class could only be obtained by a journal which was run in their interests primarily. As a consequence he placed implicit reliance on his editors, whom he selected from the foremost ranks of the profession. He insisted that his journal should be a newspaper to the extent of recording all novel methods and appliances in its field, but the criticisms of these innovations he left solely to the judgment of his editorial staff. In the second place, he was one of the first among American publishers to preach the advantages of vigorous publicity campaigns through advertising; he proved this so completely that the pioneer work he did is likely to be underestimated at the present time. Had he lived to carry out his plans for the "American Exporter," it is safe to say he would have become a great factor in building up the foreign business of our American manufacturers, for he was an adept in devising means of publicity and everything connected with it.

View of Damietta Seen across the Nile.

THE AMERICAN SYSTEM OF FILTRATION PLANT AT DAMIETTA, EGYPT.

By Edmund B. Weston, M. Am. Soc. C. E., M. Inst. C. E., Consulting Engineer, Providence, R. I.

The Town of Damietta.—The town of Damietta, which is one of the oldest in Egypt, has a population of about 44,000 and is situated on the east bank of the chief Eastern branch of the River Nile, about eight miles from its mouth in the Mediterranean Sea. In the past, it has been a very flourishing town and one of the principal shipping ports of Egypt, but its commerce and industries have been greatly injured by the prosperity of Alexandria and by the Suez Canal.

Viewed from the railway station, near the harbor, Damietta looks quite imposing with its lofty houses bordering on the river. The interior of the town, however, has quite a different appearance, as on every hand are ruinous old buildings and walls. The houses of more than one story have handsomely carved wooden jutties and lattice work, and in most cases are very ancient. The principal street is rather more than one mile in length and forms the bustling and well-stocked bazar of the town. There are four Christian chuches in Damietta. The trade of the town is principally carried on by native merchants.

Very little is known of the early history of Damietta. It attained a great reputation during the Arabian era owing to the resistance it offered to the Crusaders. The town of that time was located further to the north than the present town. In 1218 the old town was besieged by King John of Jerusalem and after various vicissitudes it was taken by the Christians, but in 1221 they were compelled by treaty to evacuate the town. In 1249 St. Louis (King Louis IX of France), on his first Crusade, landed near Damietta and captured the place, but in the following year the Christians had to restore it to the Saracens as part of the ransom of St. Louis, who had been taken prisoner during the disastrous battle before Mansourah. In 1250, owing to a resolution of the Emirs, the old town was destroyed, and the present town built on the east bank of the river further to the south.

Former Water Works.—The water works of Damietta before the installation of the American system of filtration plant described in this article consisted of a covered reservoir or settling basin, having a capacity of about 3,800,000 U. S. gal., located adjacent to the River Nile. The water flowed by gravity to the reservoir from the River Nile or from a canal connected to the River Nile several miles above the reservoir. The water was taken from the reservoir and supplied to the inhabitants by sakkas (water-carriers) in goatskin sacks carried either by themselves or by donkeys.

The walls of the old covered reservoir were of brick masonry, the bottom of concrete and the roof was covered with sheet corrugated galvanized iron. The roof was supported by old railroad rails used as columns (of one rail each), which rested upon masonry foundations and carried old rails used as joists, running the length of the reservoir, which were braced at intervals with wrought-iron rods. These joists supported by the columns were about 15 ft. apart and the corrugated iron sheets were secured to them, rounding up from each joist in the form of a segment of a circle with a rise of about 3 ft.

The masonry walls extended about 4.5 ft. above the roof to protect the reservoir from floods. In the end wall nearest to the river there were two entrances, and on a ledge inside of the wall there were six hand pumps placed about 12 ft. apart. The sakkas who delivered the water to the inhabitants filled their sacks from these pumps.

The object of the reservoir was to allow the large quantity of silt usually in the Nile water to settle.

The reservoir has been done away with, and where it was situated a preliminary subsidence basin has been built.

Filter Plant.—The filter plant now purifies the water supply of Damietta and has a capacity of 913,040 U. S. gal. per 24 hours, and is arranged for an immediate increase of 456,520 U. S. gal. per 24 hours.

The filter plant is at the south end of the town, about 200 ft. from the River Nile, as shown in the general plan. Filter 1 and coagulation and subsidence basin 3 are not yet built.

The raw water is taken directly from the River Nile during the high stages of the river, but during the low stages the salt water from the Mediterranean Sea backs up and the water is taken from a canal which is connected with the river above where the water is affected by the sea.

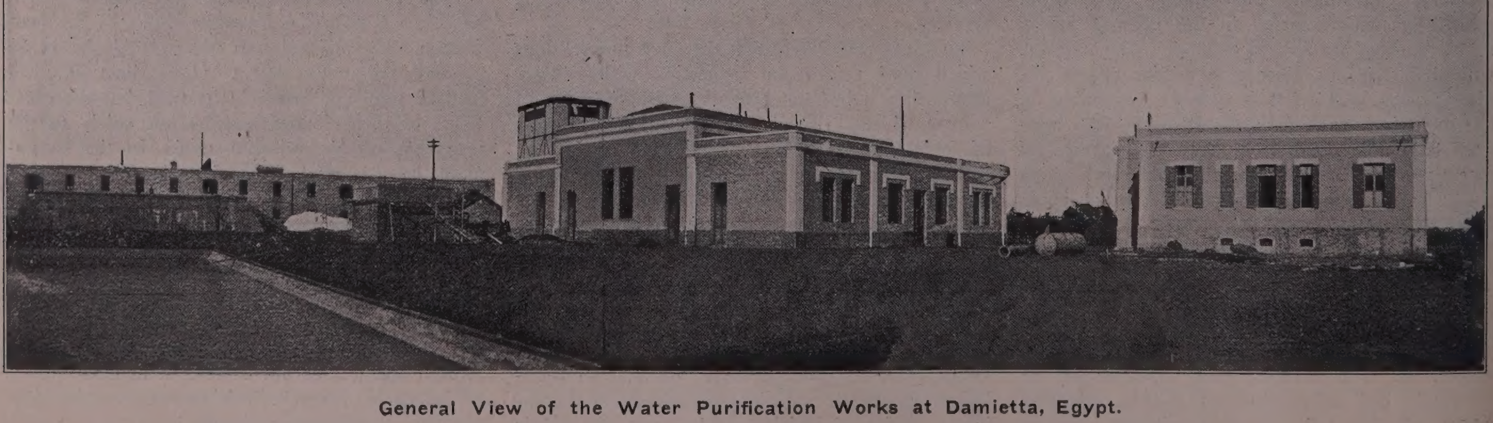
The plant for the purification of the water consists of a preliminary subsidence basin, two coagulation and subsidence basins, and a filter building containing the filters, engines and pumps, filtered water well, and their auxiliaries.

The water is pumped from the river or canal by a low lift pump to the preliminary subsidence basin, and then by another low lift pump to the coagulation and subsidence basins, whence it flows by gravity to the filters and is discharged into the filtered water well, and is pumped from the filtered water well by high lift pumps to a standpipe, about one mile away, having an elevation of about 70 ft. above the level of the ground at the filter plant. The coagulant is fed by gravity to the water on its passage from the preliminary subsidence basin to the coagulation and subsidence basins.

In the left foreground of the general view of the filter plant is a portion of the preliminary subsidence basin. Directly back of this are the coagulation and subsidence basins, which are built of brick masonry and plastered inside and out with Portland cement mortar. The long building in the extreme background is a Government hospital. The filter building is in the center. On the left, between the filter building and the preliminary subsidence basin, is the pump well, which is also constructed of brick masonry and plastered inside and out with Portland cement mortar. On the right is the superintendent's residence. In the background on the right can be seen masts and spars of vessels on the River Nile.

In building the preliminary subsidence basin, the bottom of the basin was made about 6 ft. higher than the bottom of the old covered reservoir which has been described. This was done by filling in a layer of sand, upon which sheet bitumen about ⅜ in. thick was laid, then putting in another layer of sand upon the top of the bitumen, and laying about 12 in. of macadam over the last layer of sand.

The masonry walls of the preliminary subsidence basin rest upon what was the bottom of the



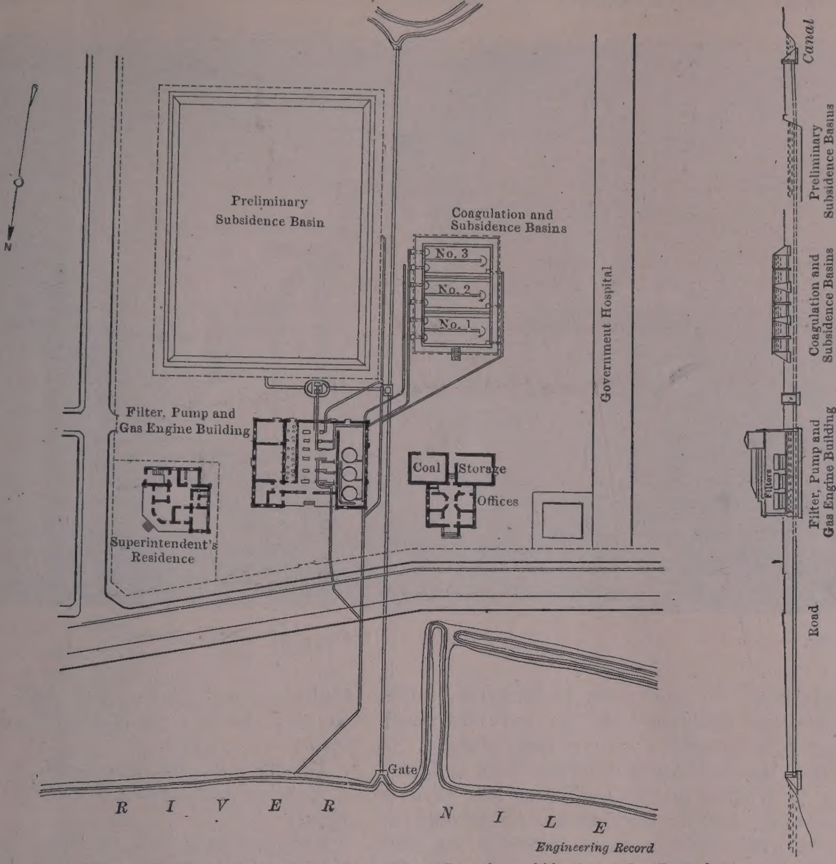
General View of the Water Purification Works at Damietta, Egypt.

old covered reservoir and are located a few feet inside of the old covered reservoir walls, earth being filled in between the walls. They were constructed by first building a main wall of brick masonry and covering it with sheet bitumen about ⅜ in. thick, which was joined to the bitumen of the bottom, and then laying a brick masonry lining over the bitumen and plastering the face of the lining with Portland cement mortar.

The depth of the preliminary subsidence basin is to be increased to a height corresponding to an elevation of about 2 ft. below the top of the pump well shown in the figure. This is to be done by building an earthen embankment with sloping sides and continuing the brick masonry walls up on the interior side to the top of the embankment.

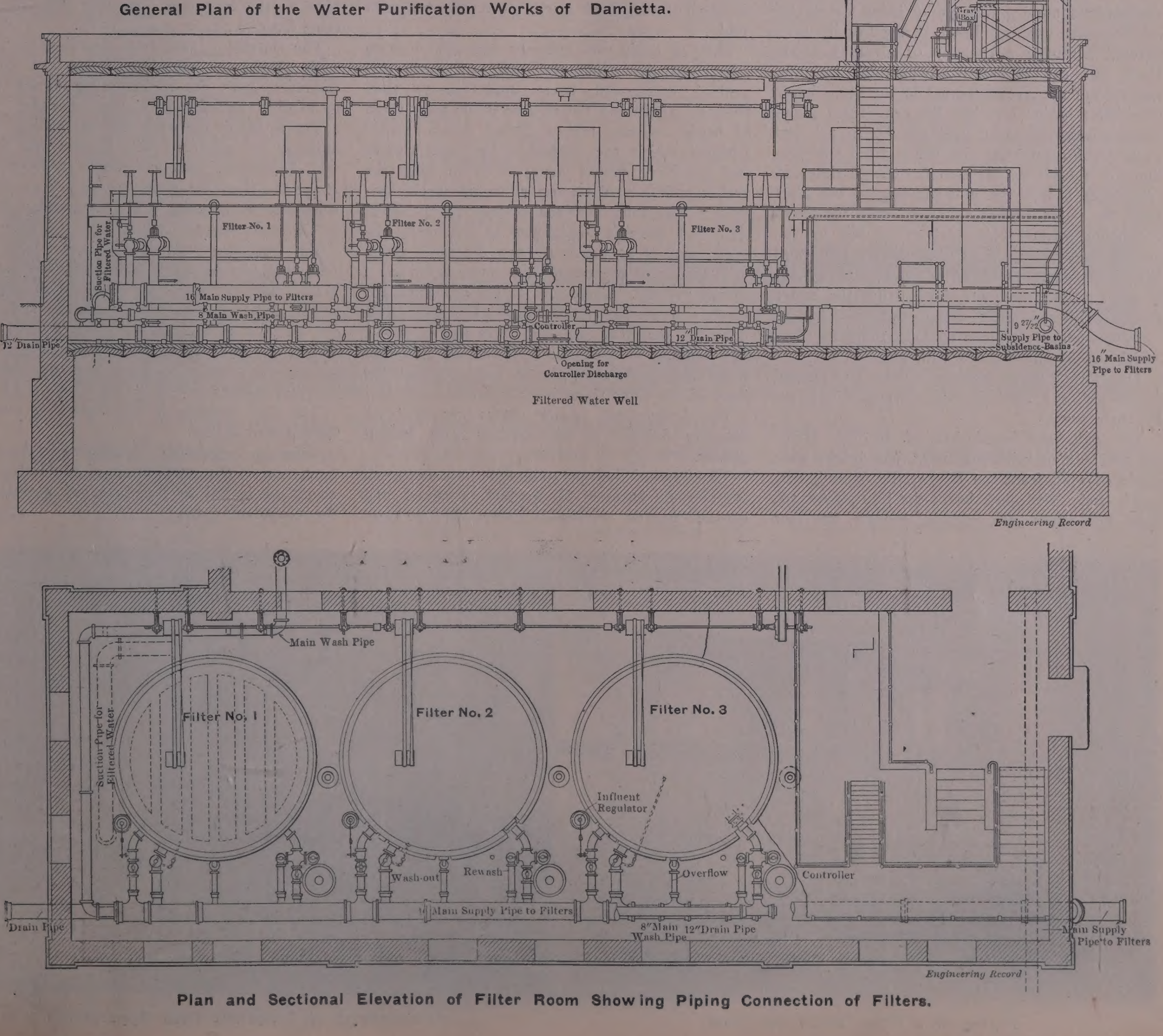
Filter Building.—The filter building is divided into a filter room, a coagulant room, an engine and pump room, a gas generator room, a storage room, a workshop, and an office. There is a filtered water well under a portion of the filter room.

The filter room contains two 15-ft. steel filters of the Jewell gravity type, supported on masonry foundations, and their piping and auxiliaries, and there is space left for a third filter to be in-


N
Preliminary Subsidence Basin
Coagulation and Subsidence Basins
No. 3
No. 2
No. 1
Government Hospital
Filter, Pump and Gas Engine Building
Coal
Storage
Offices
Superintendent's Residence
Gate
R I V E R N I L E
Canal
Preliminary Subsidence Basins
Coagulation and Subsidence Basins
Filters
Filter, Pump and Gas Engine Building
Road

Engineering Record

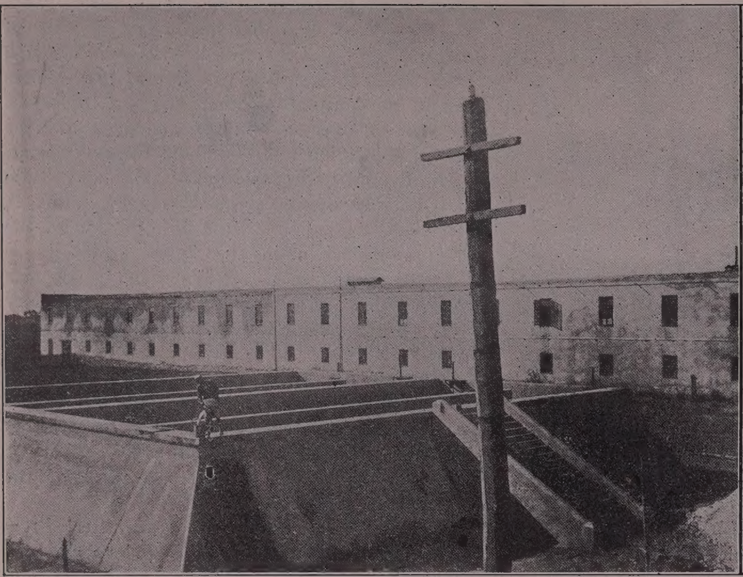
General Plan of the Water Purification Works of Damietta.


Coagulant Mix. Tank
Grav. Box
Suction Pipe for Filtered Water
Filter No. 1
Filter No. 2
Filter No. 3
16 Main Supply Pipe to Filters
8 Main Wash Pipe
Controller
12 Drain Pipe
12 Drain Pipe
Opening for Controller Discharge
9 27/32 Supply Pipe to Subsidence Basins
16" Main Supply Pipe to Filters
Filtered Water Well
Main Wash Pipe
Suction Pipe for Filtered Water
Influent Regulator
Wash-out
Rewash
Overflow
Controller
Drain Pipe
16 Main Supply Pipe to Filters
8" Main Wash Pipe
12" Drain Pipe
Main Supply Pipe to Filters

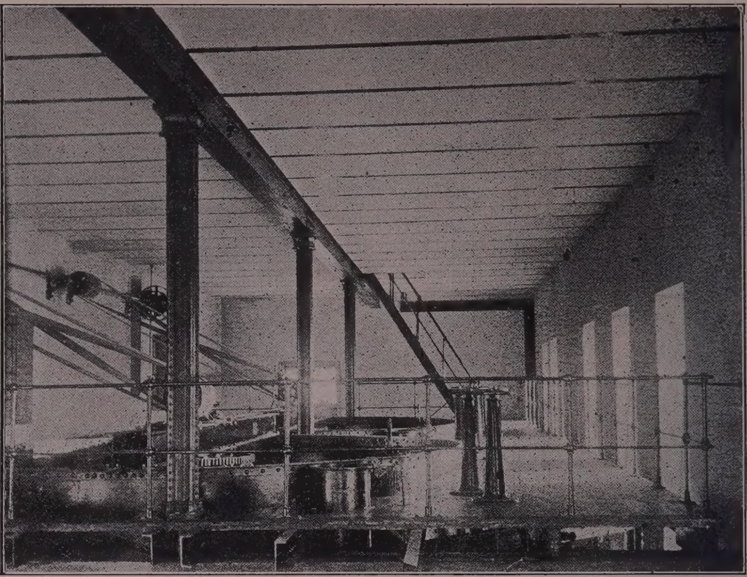
Engineering Record

Engineering Record

Plan and Sectional Elevation of Filter Room Showing Piping Connection of Filters.



Coagulation and Subsidence Basins.



Interior of Filter Room.

stalled in the future. Each filter has a capacity of 456,520 U. S. gal. per 24 hours.

The coagulant room contains the sulphate of alumina mixing tanks, the gravity box, and hard rubber and lead fittings and piping for feeding the coagulant.

The engine and pump room contains four gas engines and pumps, each pump being driven by belt by a gas engine. There is one low lift centrifugal pump of a capacity of about 3,424,000 U. S. gal. per 24 hours for pumping the raw water from the river or canal to the preliminary subsidence basin; one low lift centrifugal pump of a capacity of about 1,084,000 U. S. gal. per 24 hours for pumping the water from the preliminary subsidence basin to the coagulation and subsidence basins, the line shafting in the filter room for operating the agitators when the filters are being washed being driven by belt by the gas engine which drives this pump; two high lift piston pumps each of a capacity of 457,000 U. S. gal. per 24 hours for raising the water from the filtered water well to the standpipe.

The gas generator room contains the generators which supply the engines with gas.

The storage room, workshop, office and filtered water well are used for the purposes indicated by their names.

The walls and foundations of the filter building are built of brick masonry. The bricks were made of mud from the River Nile, moulded by hand, and dried and burnt in kilns. As the Nile mud does not contain enough clay for hard bricks, the bricks are of a porous, sandy nature and easily broken; but notwithstanding their poor quality, they are quite durable, as there is but little rain and not any frost at Damietta to produce injurious effects. Nile mud is extensively used for building material throughout Egypt. The walls of many structures are constructed of sun-dried brick, plastered over with mud.

There is a hip roof over the engine and pump room and gas generator room, of sheet galvanized corrugated iron supported by steel trusses. There is a flat roof over the filter room of brick masonry arches turned between steel I-beams which are supported by steel girders and columns, mortar being filled in over the arches and finished on top with waterproof material. The roof over the storage room, workshop and office is constructed in practically the same manner as the roof over the filter room.

The floor of the engine and pump room is of square red tile. The floors of the gas generator room and storage room are of concrete. The floors of the workshop and office are of wood. The landing at the main entrance of the filter room is paved with square red tile and the floor of the filter room is of concrete.

The foundations of the filters are of brick masonry finished on the outside with cement plaster.

The floor of the operating floor is constructed of two thicknesses of dressed, tongued and grooved boards, similar to spruce, laid at right angles to each other. The wood floor is laid on steel channels which are supported by steel beams and columns.

The floor of the filter room, which is about 4 ft. below the landing, is reached by masonry steps.

Iron stairways lead up from the filter room floor to the operating floor and from the operating floor to the coagulant room.

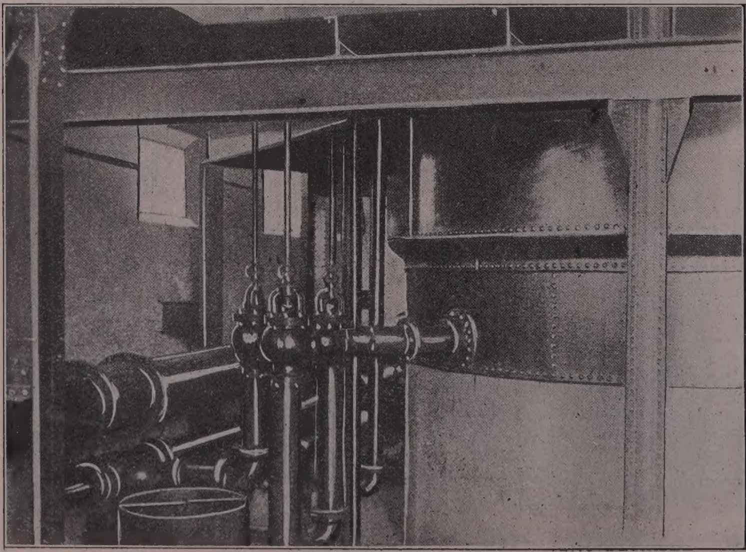
The outside of the filter building is finished with plaster to represent a modern concrete structure, with the underpinning struck off so as to give the effect of coursed masonry.

The inside of the walls and the ceilings of the building are plastered with mortar and finished with kalsomine. For a distance of about 3.5 ft. above the floor the walls are of a slate color to represent wainscoting. The remaining portions of the walls and the ceilings are of a drab color.

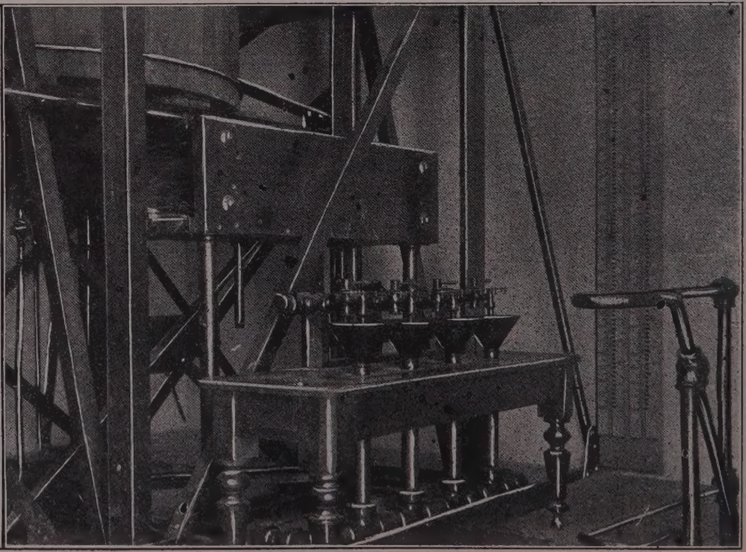
The coagulant room is a structure built above one end of the filter room. It has an iron frame, and the walls are made with expanded metal plastered with mortar outside and inside, the surface of the walls having a hard finish. It has a peak roof which is covered with sheet galvanized corrugated iron, and the roof has a wood cornice.

The filter building is well lighted by windows having iron sashes.

Coagulant.—Sulphate of alumina is the coagulant used in the purification of the water. The coagulant is fed to the water by gravity from the coagulant room.



Piping of a Filter below the Floor.



Arrangement of Coagulant Feed Apparatus.

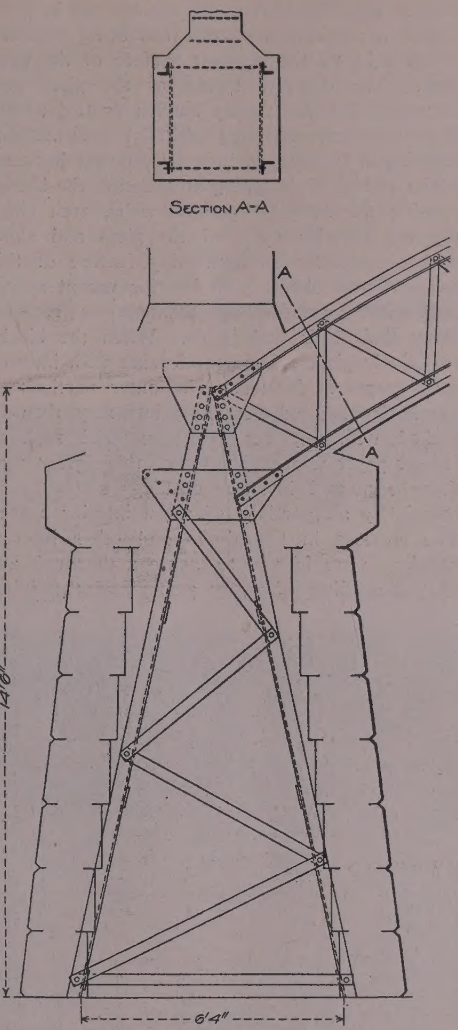
System of Filtration.—The process of filtration by the American system may be briefly described as follows: To the raw water to be purified is first added the desired quantity of coagulant (sulphate of alumina in the form of a weak solution). The water then passes slowly through the coagulation and subsidence basins where coagulation and subsidence takes place, or, in other words, the sulphate of alumina is decomposed and a flocculent gelatinous precipitate of aluminum hydrate is formed. This precipitate surrounds, entangles and aggregates the suspended substances, bacteria and organic matter, and slowly carries them down through the water, and results in the greater part of them being deposited upon the bottoms of the coagulation and subsidence basins. Generally speaking, it may be said that the action of the aluminum hydrate is much the same as the action of the white of an egg in clearing turbid coffee. From the coagulation and subsidence basins the clarified water flows to, upon and through the filter-beds, which act as strainers and remove the remaining coagulated particles, including bacteria. In a few minutes after a filter is put in operation a thin gelatinous layer is formed upon the top of the filter-bed, which adds materially to the thoroughness of the process of filtration. A further action of the aluminum hydrate is to unite with the soluble coloring matter in the water, thereby rendering the effluent nearly colorless.

Contract.—The Egyptian Government controls the water supply of Damietta, and the Jewell gravity type of filter was principally selected by the Government on account of the excellent results obtained with the same kind of filters at Mansourah and Alexandria, Egypt.

The Jewell Export Filter Co. furnished and erected the filters and their auxiliaries, under contract with the Municipality of Damietta. The other portions of the filter plant, including the filter building, filtered water well, coagulation and subsidence basins, preliminary subsidence basin, and pump combinations, were contracted for with other parties by the Municipality of Damietta.

The plans for the filter plant were prepared under the direction of the writer, as consulting engineer of the Jewell Export Filter Co., and Mr. Karl Abel, engineer of the Ministry of the Interior. Mr. Abel supervised the erection of the filter plant on behalf of the Government and the Municipality of Damietta. Mr. Daniel E. Peckham represented the Jewell Export Filter Co. as superintendent of construction during the erection of their portion of the filter plant.

Test.—The filter plant was completed about the middle of November, 1906, and was then run for one week by the Jewell Export Filter Co.'s superintendent of construction, who left Egypt immediately afterwards. The results obtained during the run were eminently satisfactory to all parties concerned, and the filter plant was visited by a large number of people, including Government officials, all of whom appeared to be very much pleased and interested. The filters and their auxiliaries furnished and erected by the company have been approved and accepted on behalf of the Egyptian Government and Municipality of Damietta.



Rib and Pier Reinforcement.

Extensions.—It is proposed in the near future to supply filtered water from the Damietta filter plant to Ras-el-Bahr, which is one of the leading summer resorts of Egypt.

Ras-el-Bahr is at the mouth of the River Nile by the Mediterranean Sea, about eight miles from Damietta. People from all of the principal inland towns of Egypt go there to spend the hot season. The buildings consist mainly of wooden frames covered with coarse matting. As there is no rain during the hot season, the matting answers for protection from the sun.

Rapid Building Construction has marked the erection of the Trinity Annex and Realty Building described in The Engineering Record on March 2 and in several previous issues. From the time the first steel columns were set, on September 15, 1906, to the opening of the building on May 1, is only seven months, but in this time 9,000 tons of steel from Pittsburg, 1,000,000 bricks from New Jersey and Albany, 1,000,000 sq. ft. of tile from Raritan and 300,000 cu. ft. of stone from New England quarries have been assembled and set in place. Six months after the erection of the Trinity Annex was begun the American Locomotive Co. was transacting business in its new offices on the sixteenth floor.

The Hudson River Bridge at Sandy Hill, N. Y.

A reinforced concrete bridge has recently been completed across the Hudson River at Sandy Hill, N. Y., from the plans of Prof. Wm. H. Burr, which has been briefly described in a number of journals devoted to concrete. The main engineering features have not been explained, however, and the following notes concerning them are accordingly taken from a paper by Prof. Burr entitled "The Reinforced Concrete Bridge across the Hudson River at Sandy Hill, N. Y.", which has just appeared in the "Proceedings" of the American Society of Civil Engineers (Vol. 33, page 394), and will be presented for discussion on May 15. The bridge has a total length of 1,025 ft. and provides for both highway and passenger traffic and the transportation of materials in cars between the mills of the Union Bag & Paper Co. and the railway tracks on either side of the river. It was built jointly by the company and Saratoga and Washington Counties and replaces an old timber bridge. The width of the bridge, between the outer surfaces of the spandrel walls, is 35 ft. 8 in., while the width between the coping stones is 32 ft. The latter width affords room for a roadway 26 ft. 9 in. wide and a 5-ft., 3-in. sidewalk. On one side of the roadway is placed a standard-gauge railway track, the center of the nearest rail being 4 ft. 3 in. from the adjacent coping.

There are fifteen arch spans, each 60 ft. in the clear, the piers being 6 ft. thick at the top between the springing joints of the arch ring and 9 ft. thick 13 ft. below the springing joints at the top of the foundation mass of concrete. The radius of the intrados is 57 ft. 6 in. and the rise of each arch is 8 ft. 6 in. The depth of the ring stones is 18 in. at the crown and 30 in. at the skewback or springing joint.

The spandrel walls, arch ring and exterior walls of the piers and abutments are composed of concrete blocks with interior spaces filled with thin mortar or thick grout after being laid in place. The railing is also of concrete.

The Reinforced Concrete Bridge across the Hudson River at Sandy Hill, N. Y.

The main supporting members of each span are five arch ribs, the two heavier ribs being placed under the railway track, each rail being over the center of a rib. The other three ribs are placed equi-distant from each other and from the adjacent railway rib, 5 ft. 10 in. from center to center. Internal spandrel walls, each 12 in. thick for the three lighter ribs, and 15 in. thick under the railway track, support a reinforced concrete floor plate or slab 8 in. thick for the entire roadway and 6 in. thick for the sidewalk, the top surface of the latter being 8 in. above the former. The top surface of the concrete is the finished sidewalk surface, but an asphalt pavement, crowned to a thickness of 4 in. between the railway tracks and 2 in. at the gutter, is laid for the roadway pavement, bricks suitably formed being laid on each side of each rail. The outer edges of the sidewalk plates and their proportionate loads are carried by the spandrel walls and the ring stones.

The structure is designed to carry its own weight, a snow load of 12 lb. per square foot and a moving load of 100 lb. per square foot over the roadway and sidewalk, while the ribs under the railway track are designed for a moving load consisting of a train of cars, each, with its load, weighing 120,000 lb., carried on two trucks with four wheels each. The reinforced concrete roadway floor plates are also designed to carry a truck weighing 12 tons resting on a wheel base of 10x6 ft.

In the computations the modulus of elasticity of concrete was taken at 2,000,000 lb. and that of steel at 30,000,000 lb.

The bridge is designed to carry the preceding loads without exceeding a compressive stress of 500 lb. per square inch in the concrete. For all ordinary loadings, even with the railway loads prescribed above, that compressive stress does not exceed about 400 lb. The tensile resistance of the concrete in any part is not taken into account.

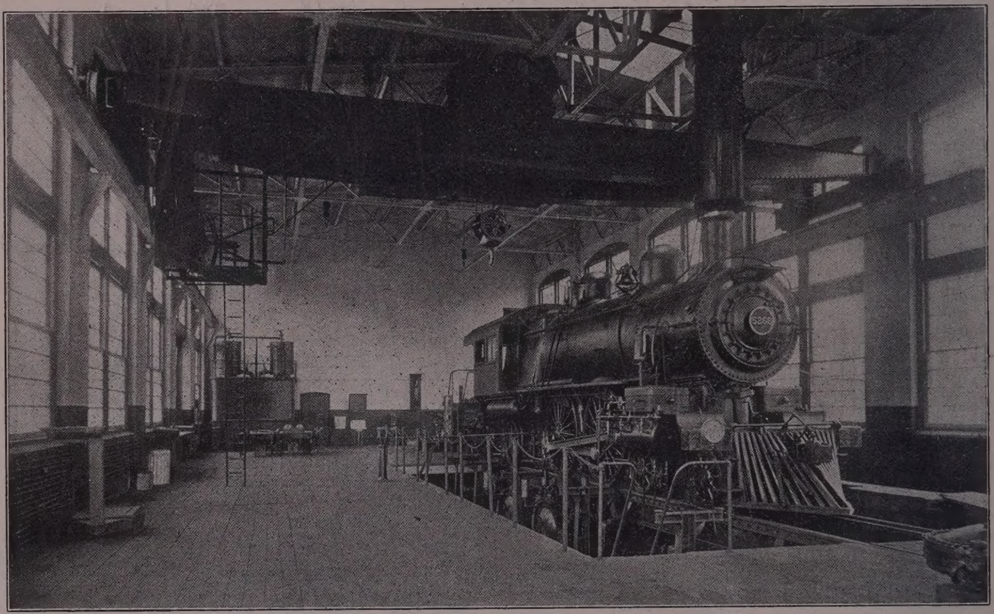
The cross-section of the ribs under the railway tracks is 3 ft. square at the springing joints and 3 ft. by 1 ft. 10 in. at the crown, while the three lighter ribs are 2 ft. 8 in. by 2 ft. 3 in. at the springing joint and 2 ft. 8 in. by 1 ft. 2 in. at the crown. The steel reinforcement of each rib consists of four 3x2½x5/16-in. angles embedded in the concrete, with not less than 2 in. of concrete outside them at all points. These reinforced angles are latticed into their proper relative positions by 2¼x5/16-in. steel lattice bars.

It was found that these reinforcing ribs could not be secured in the shape of ordinary riveted members without great delay and excessive cost, and therefore the steel angles and lattice bars were shipped directly from the mills to the bridge site, where a portable punch, shears and simple bending rolls were improvised. As all fabrication was done at the bridge site, all the work was bolted up, no rivets whatever being used. The detail sketch shows how rigidly the steel reinforcement of the ribs was joined at the tops of the piers with a corresponding reinforcement running down to the bottom of the concrete hearting of the piers.

In order to lighten the structure as much as possible and to economize in material, panels of sheeting 5 ft. long and 6 ft. apart are omitted between the highway ribs, but the sheeting is made complete between the two ribs under the rails of the railway. The sheeting itself, wherever used, is 6 in. thick; a thickness of 4 in. would probably have been sufficient, but, as the bridge is partly for a rather heavy railway traffic, and as the open spandrel spaces beneath the floor may be used eventually for pipes and conduits, it was considered advisable to adopt a thickness of 6 in.

The steel reinforcement for the entire work, exclusive of the ribs, consists of Thacher rods. The reinforcing rods for the roadway and sidewalk lap past each other, so as to make a continuous plate from one side of the bridge to the other. Further than this, the ends of the sidewalk rods extend about half way through the coping, being bent so as to increase the firmness of hold. This entire arrangement makes a continuous reinforced structure, at the roadway elevation, of spandrel walls, roadway and sidewalk plates. The interior spandrel walls have embedded in them throughout the mass of their higher portions short ⅜-in. rods spaced 12 in. apart on centers. Near the piers these walls are fully 9 ft. high and only 12 in. thick under the roadway. Although their thickness under the railway is 15 in., it was considered advisable to supply positive resistance against any tendency to cleavage or splitting in any direction approximately vertical. Steel reinforcement also insures a firm and continuous bond between the ring stones under the exterior spandrel walls and the sheeting, together with the interior spandrel walls. The structure is essentially of skeleton character, with economical interior vacant spaces, but its parts are rigidly bound together in a positive manner with the steel reinforcement and by continuity of concrete work the steel being nowhere within 2 in. of the exterior surface of the concrete. The concrete blocks of the piers and abutments are also rigidly bonded or tied to the interior concrete hearting with flat steel anchors reaching at least 18 in. into the concrete backing.

The system of designing and casting the blocks forming the exterior spandrel walls, arch rings and the exterior walls of the piers and abutments constitutes an interesting feature of this work. These blocks have interior vacant spaces and with corresponding channels or recesses along their beds and joints. When the blocks are laid in place a honeycomb mass with internal open spaces is formed. The outer portions of the horizontal and vertical joints may then be packed with any convenient material such as jute or paper waste. Mortar or thick grout may then be poured into the openings so as to fill completely all portions of these interior spaces. The recesses in the blocks and other internal openings were formed to insure a thorough and complete filling of every portion of the joints and spaces in the blocks as cast. These recesses can be formed quickly and cheaply by the suitable use of partially filled paper bags of sand, as was done in this case. After the block is set these paper bags are punctured and the sand at once runs out, leaving the desired voids. Furthermore, this process makes every wall thus formed essentially monolithic. After the mortar has hardened, the joints are raked out in the ordinary manner and pointed, as in any masonry. These blocks were cast in wooden forms, the concrete for the entire structure being a 1:2:4 mixture. The exterior surface of the blocks is essentially composed of a 2 to 1 mortar. The forms were well made of smoothly surfaced stuff, although no extraordinary care or skilled labor was used. The general effect of the structure, when observed as a whole, even close at hand, is that of masonry blocks of unusually smooth and regular texture.



Interior of the Locomotive Testing Plant at Altoona.

Over each pier and the crown of each arch the roadway and sidewalk plates are cut throughout the entire width between the copings of the exterior spandrel walls. The interior spandrel walls are also cut at the same points. These openings form expansion joints and are covered with 4x½-in. steel plates. No other provision is made for expansion or contraction throughout the entire structure. The ribs, piers and abutments form a continuous reinforced concrete mass a little more than 1,000 ft. long, without any provision for change of length, due to varying temperature or originating from other sources.

The cement used for this work was the Ironclad brand, manufactured at Glens Falls, N. Y., about four miles from the site of the bridge. The broken stone used was crushed local limestone, the specifications requiring 1½ in. as the largest dimension. The sand was also a local material. The concrete for the mass work of the bridge was all produced by a Smith mixer. The concrete of the blocks was composed of the finer portions of the crushed material, much of it—especially the exterior portions—being equivalent to about 2 to 1 mortar.

Work on the bridge was begun on May 4, 1906, and all the concrete work was completed on Jan. 8, 1907, the total time occupied in construction being 8 months and 4 days. The total cost of the structure, including the lamp posts and the resident engineering organization, was about $77,000, about $5,000 of this amount being due to extra labor during nights and Sundays. This extra cost of overtime work was incurred to hasten completion, which was imperative in consequence of the dangerous condition of the old wooden bridge, the only available means of crossing the river at this point prior to the completion of the new structure. A little extra expense was also incurred in heating—by use of salamanders—various portions of the work during the extremely cold weather of the six weeks prior to the close of the work. Under ordinary conditions, therefore, the total cost of the bridge would scarcely have exceeded $72,000.

The river bed at Sandy Hill is practically clean rock with only a little detritus on its surface. During the summer the water is shallow, nowhere exceeding 2 or 3 ft. in depth. The foundation masses of concrete of all the piers, therefore, could be put in place quickly and cheaply within simple cofferdams involving little time or cost. To this condition is due largely the comparatively short time required for the construction of the bridge and its low cost.

The method of casting the blocks with the internal openings, and the high degree of efficiency displayed in the prosecution of the work, were both due to the resident engineer, Mr. M. O. Kasson, who was continuously engaged on it from the beginning to the end of the construction. The entire work was done by day labor under the charge of the resident engineer.

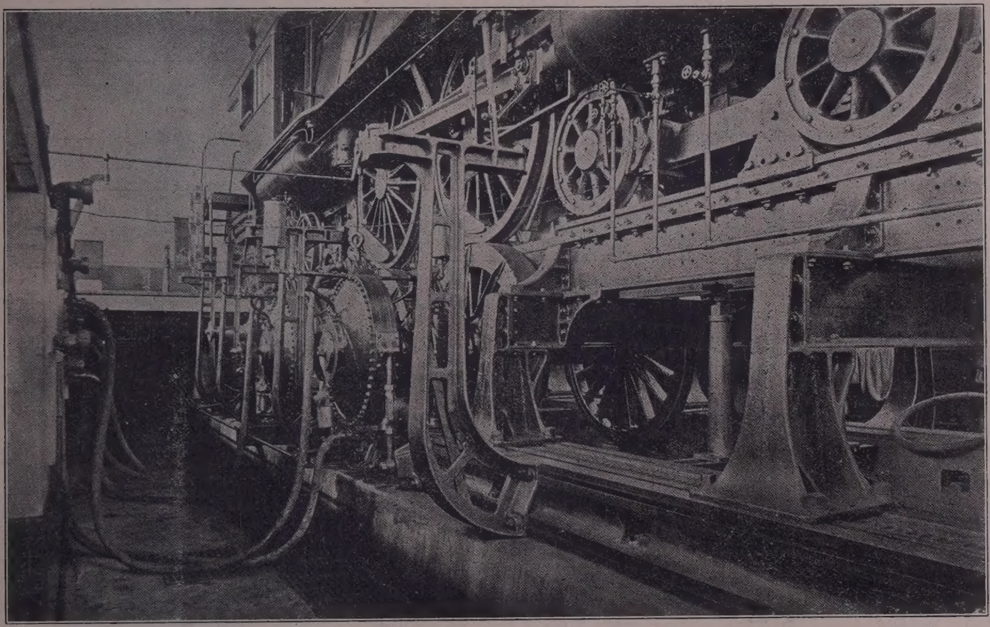
The method of stiffening the ribs is practically the Melan system of construction, and it was used under arrangement with the Concrete Steel Engineering Co., of the City of New York, which company owns the Melan patents.

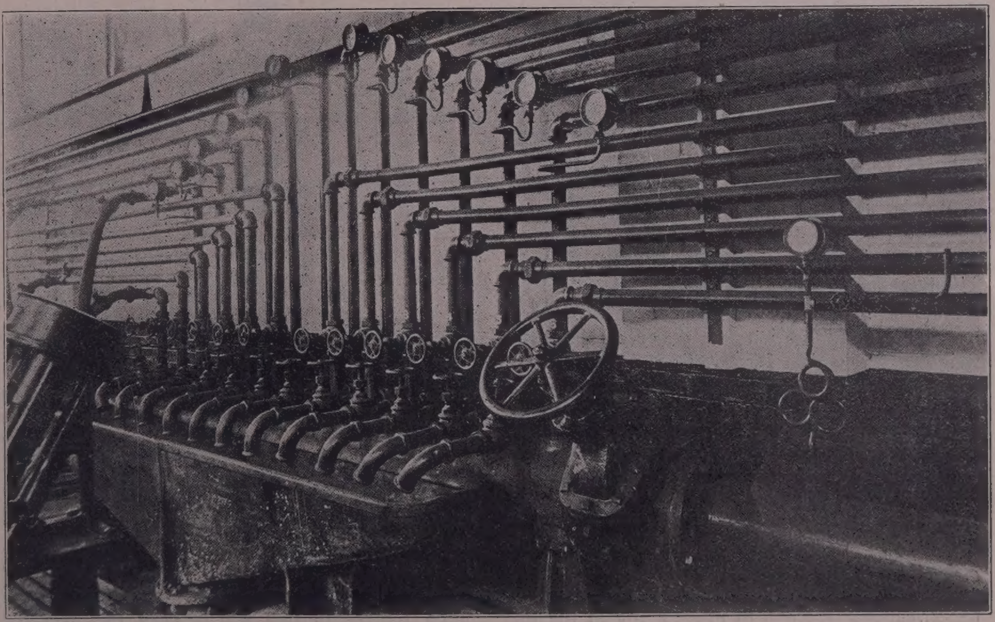
The Locomotive Testing Plant of the Pennsylvania R. R. at Altoona.

Since Nov. 19, 1906, the locomotive testing plant of the Pennsylvania R. R. at Altoona has been in continuous operation and the force of sixteen men have made on an average about three complete tests each week. Certain portions of the apparatus were temporarily installed at the Louisiana Purchase Exposition and experience gained through operation there has been embodied in the plant at Altoona. A separate building of steel and brick has been erected for housing the apparatus. The floor is on the track level and is made in sections which can be removed by the traveling crane. The space beneath the removable floor is used for storing absorption brakes, supporting wheels and other parts when not in use. On the same level as the storage space and below the main floor is all the apparatus for water supply used in controlling the brakes.

The driving wheels of the locomotive under test rest upon supporting wheels with rims shaped to correspond with the head of the rail. The axles of these supporting wheels are extended and carry Alden absorption brakes. The turning of the driving wheels causes the supporting wheels to revolve and the latter may be retarded to any desired extent by the brakes. The work actually done by the locomotive consists in overcoming the friction resistance of the supporting wheels and brakes, the resulting force exerted at the drawbar being measured by a traction dynamometer. The axles of the supporting wheels run in heavy pedestals secured to cast-iron bed plates resting upon a concrete foundation. There are two bed plates running parallel with the track, and in order that the supporting wheels may be directly beneath the locomotive drivers, these bed plates are provided with T slots, so that the pedestals can be moved along parallel to the track and secured in any position to suit the particular engine under test. The only wheels of the locomotive which move during a test are the drivers. The wheels of the leading truck rest upon rails secured to I-beams and supported upon the same bed plates which carry the pedestals. The wheels of the trailing truck rest upon supporting wheels (which remain stationary during the test) and are carried by pedestals secured to the longitudinal bed plates.

When preparing the plant to receive a locomotive, the pedestals are carefully bolted to the bed plates and so spaced that there will be a pair of supporting wheels directly beneath each pair of drivers of the locomotive. A section of special rail is next bolted to the inside faces of the supporting wheels. This rail is composed of a heavy I-beam, to the top of which is secured a grooved head in which the flanges of the drivers run. The tops of the supporting wheels are in line with the track entering the building, so that a locomotive can be backed in and the drivers will run on their flanges until in position directly over their supporting wheels. After a locomotive has been secured in place and its drawbar attached to the dynamometer, these grooved rails upon which it ran in are removed, leaving the drivers resting upon the supporting wheels.


General View of Supports under a Locomotive.


Valves on Inlet and Discharge Pipes of Brakes.

The axle for each pair of supporting wheels carries upon each of its overhung ends an Alden absorption brake. Each brake consists of two smooth circular cast-iron discs, keyed to the supporting wheel axle. On each side of each one of these discs is a thin copper diaphragm secured at its periphery and inner edge to a housing which does not revolve and has its bearing upon the hubs of the circular revolving discs. The stationary housing is so designed that when it is filled with water under pressure the copper discs are forced against the revolving discs, creating friction. Provision is made for securing continuous and uniform lubrication of the surfaces of these revolving discs, and the water is caused to flow through the housing in order to carry away the heat generated. The water thus performs two functions: first, in supplying pressure to cause the friction, and second, in carrying away the heat generated by the friction.

Each brake is connected with the source of water supply by a flexible hose and is connected with the discharge pipes by another flexible hose. The discharge pipes for all the brakes empty into an iron trough and each pipe is provided with a valve located adjacent to the valve in the supply pipe for the same brake. In placing the load upon the locomotive these valves are adjusted until the individual brakes each absorb their share of the work. After this preliminary adjustment has been secured the power absorbed by all of the brakes may be increased or decreased by operating a large valve in the supply main.

In order to secure water under uniform pressure for use in the brakes, an elevated tank is located near the testing plant building and a two-stage centrifugal pump driven by a 75-h.-p. electric motor delivers the water under a constant pressure of 75 lb. per sq. in. to the main header, from which branch pipes lead to the individual brakes. The water discharged from the brakes empties into the iron trough shown in the photograph and thence runs by gravity into a tank located beneath the floor of the building. From this intermediate tank it is forced back into the outside supply tank by a centrifugal pump driven by a 20-h.-p. electric motor. The outside supply tank is regularly used by locomotives going to and from a roundhouse in the vicinity, so that the warm water returning to the tank from the testing plant is not wasted and does not increase the temperature of the water to an appreciable extent. The entire water system is designed to supply 900 gal. of water per minute at low pressure when running high-speed tests.

The locomotive is connected to the dynamometer by an adjustable drawbar, and the dynamometer housing is provided with means for raising and lowering the dynamometer proper to bring this drawbar truly horizontal for various heights of locomotive drawbar attachments in the tailpiece, varying from 30 to 42 in. above the track. To decrease the vibration transmitted to the dynamometer through the drawbar, two safety bars are provided between the locomotive and the dynamometer frame. At their ends these bars have universal joints to insure perfect freedom of adjustment, and each bar is provided with an oil dashpot near the dynamometer end. The dash pots are in the form of double discs ground to fit their cylinders closely, and supplied with oil from founts. Their resistance to motion is adjustable by means of by-pass valves in their castings.

The traction dynamometer, which measures the drawbar pull of the locomotive is of the lever type. The weighing mechanism is supported by a frame which slides up and down in ways formed by the massive housings which are rigidly secured together and anchored to a heavy foundation. The lever system is constructed upon the Emery principle in which flexible steel fulcrum plates take the place of knife edges used in ordinary scales. As the levers are vertical instead of horizontal their weight would not come upon the fulcrum plates in the direction in which they transmit pressure. It has, therefore, been necessary in certain cases to supply two fulcrum plates with their axes at right angles, one for carrying the weight of the levers and the other for transmitting the thrust.

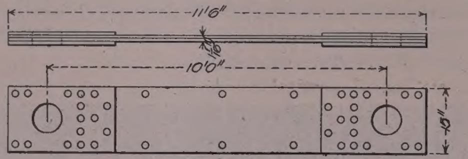
A continuous record of the test is made on a strip of paper 18 in. wide mechanically drawn over a recording table. The paper is driven by direct connection with one of the supporting wheels upon which the locomotive drivers rest. The speed reduction is so arranged that when the locomotive under test travels one mile on the supporting wheels the paper moves 52.8 in., giving a scale of 100 ft. to the inch upon the diagram. In order to secure the accurate movement of the paper it passes between a finely corrugated brass roller and another roller covered with rubber. The winding drum to which the paper is finally delivered is arranged to slip upon its shaft in order to accommodate its constantly increasing diameter as the test progresses.

A datum pen marks a continuous straight line upon the paper. A traction recording pen moves across the paper perpendicular to the datum line, its distance from the datum line being dependent upon the force transmitted by the drawbar from the locomotive. The maximum travel of this pen away from the datum line is 8 in. Two sets of springs are provided. With the heaviest set the 8-in. movement of the traction pen corresponds to a load of 80,000 lb. upon the drawbar, which represents the maximum capacity of the dynamometer. With the other set of springs the 8-in. motion of the traction pen corresponds to a pull of 40,000 lb., and with all the flat springs removed, the 8-in. motion corresponds to a 16,000-lb. load. The total motion of the drawbar to give the 8-in. movement to the recording mechanism is but 0.04 in. The multiplication of the recording and weighing mechanism is, therefore, 200 to 1.

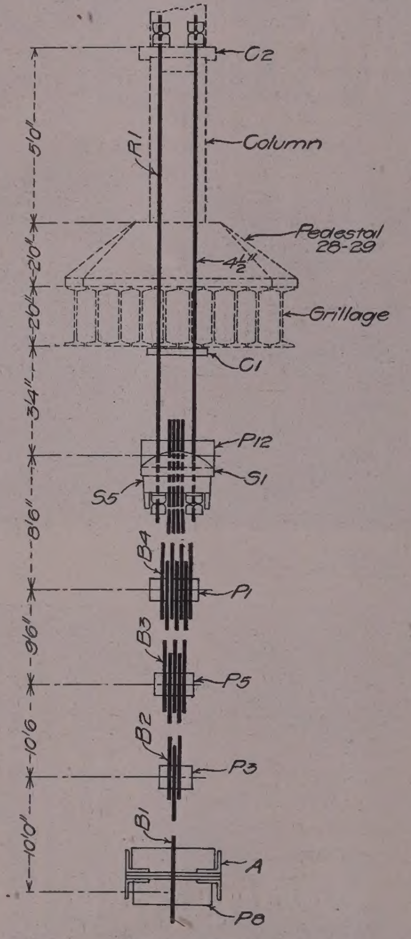
An integrator is attached to the traction recording mechanism, so that the foot-pounds of work performed by the locomotive is automatically summed up. Five additional electrically-operated pens are provided. One of them is electrically connected with a clock, so that each second is indicated by a jog in the straight line which this pen normally draws. Another pen is electrically connected to a roller rotated by the recording paper, causing the pen to make a jog in the line for every 1,000 ft. which the locomotive travels. Another pen is electrically connected to the integrator and makes a jog in its line every time the integrator measures one square inch. The remaining electrically-operated pens are used for recording such features of the test as taking indicator cards and the like. Fig. 15 shows a characteristic record from which the operation of the various pens may be followed.

For handling the coal used by the locomotive a very complete plant has been installed. Bottom dumping railroad coal cars are run in on the track beside the building and dumped into a large hopper. From this hopper the coal is carried by a bucket conveyor to two elevated reinforced concrete pockets, each of which has a capacity of about 50 tons. Each pocket is provided with a bottom cut-off gate at a convenient height above the main floor, through which coal is discharged as needed into wagons holding about 1,000 lb. each, which are run over weighing scales, pushed out to the locomotive, raised by a hydraulic elevator to the firing platform, and dumped.

Ashes from the locomotive are discharged at the pit level, placed in a wagon, raised on the hydraulic elevator to the level of the main floor, and run into a chute leading to a conveyor, delivering into an ash bin over the outside track. From there the ashes are discharged into a railroad car run in on the track below.



Anchorage Link.



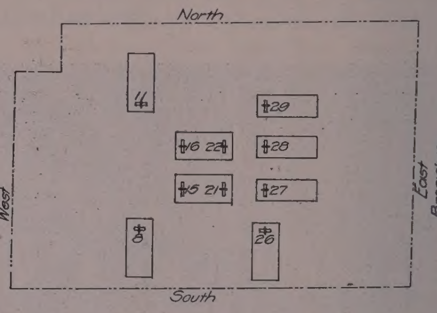
Anchor Chain.

Water used in the locomotive boiler is taken from a water supply tank located in the corner of the laboratory. It first passes through a meter, the reading of which is used as a check upon the weighing tanks. A small motor-driven centrifugal pump returns to this supply tank the overflow from the injectors used on the locomotive.

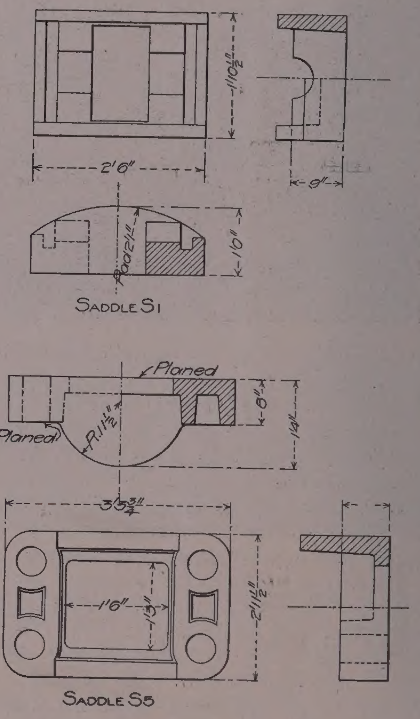
The stack into which the locomotive discharges is a great improvement over the one originally used in St. Louis. Within the enlarged head is a deflector for carrying the sparks to the outer portions of the casing where they fall out of the flow of gases and drop into a hopper, from which they are eventually removed and weighed. The entire stack is supported upon a truck which is adjustable over a distance of 16½ ft. lengthwise of the building, in order to bring it directly over the locomotive's stack wherever the latter may happen to be located. The opening in the roof is provided with a hood.

The Anchorages of the Singer Building Tower.

The 75 x 115-ft. extension of the Singer Building, in New York, is a 14-story steel cage structure with a 75-ft. front on Broadway, just above Liberty St., which is now being built at a cost of about $1,500,000. As described in The Engineering Record of Sept. 8, 1906, it will form a part of a group of buildings and extensions united into a single structure covering an area of about 24,000 sq. ft., and equipped with a single service installation. The most important architectural and engineering feature of the construction will be the lofty tower near the center of the new part of the building rising to a total height of 612 ft. above the curb or about 640 ft. above subgrade. It will have 42 accessible floors, 28 of them above the main roof of the building, and will have an ornate exterior, relieved with projecting courses and balconies.



Plan of Piers with Anchorages.



Saddle S1

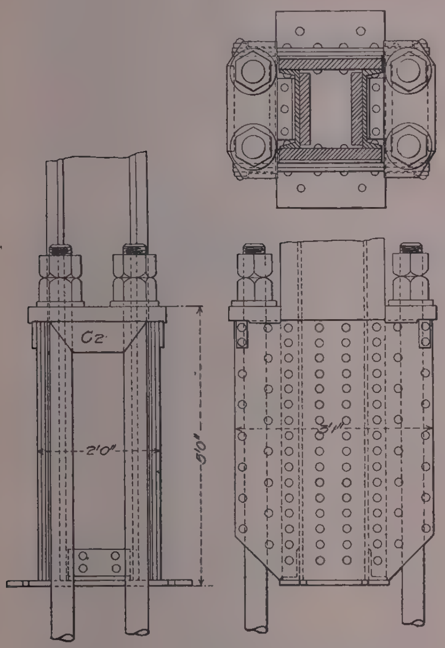
Saddle S5

Saddle Castings.

The shaft will be 63 ft. square, as large as a good size building, and will be occupied up to the 36th floor with suites of office rooms, above which there will be a circular dome 40 ft. high, containing four more floors surmounted by an ornamental lantern 63 ft. 9 in. high and a flagpole with its top nearly 674 ft. above the basement floor. The framework is entirely of steel with brick and terra cotta walls and copper sheathing, and the exterior surface is assumed to be subjected to a wind pressure of 30 lb. per sq. ft. The stresses thus developed are transmitted to the foundation through 25 systems of vertical X-bracing in the panels between the columns and floor girders.

The tower framework comprises 36 columns, spaced regularly 12 ft. on centers longitudinally and transversely. Six of the columns in the elevator shaft at the center of the building and four other interior columns, one panel distant from them, are connected by the vertical trusses formed by the wind bracing which carries these stresses to the foundation. The four columns, No. 15, 16, 21 and 22, nearest the center of the group extend just above the 43rd floor and have a total length of about 579½ ft. They have a calculated maximum static load of 950,000 lb., and a maximum uplift of about 540,000 lb. each, due to wind pressure. These stresses are provided for by a basement cross section of 160 sq. in. and by anchorage to the foundation. The other six braced columns, indicated on the diagram, terminate in the 35th story, just below the dome and are about 499 ft. in extreme height. Their maximum stresses vary up to 910,000 lb. static loads and 925,000 lb. wind stress with a corresponding maximum basement cross section of 160 sq. in.

All of the columns are seated on rectangular concrete piers with their footings carried down by wooden pneumatic caissons through sand and hard pan to solid rock about 90 ft. below the level of the Broadway curb. The loads on the piers are limited to 15 tons per square foot and are distributed over an area equal to about one-half that of the entire building. The piers were built as shafts constructed above the surface of the ground and afterwards sunk to bed-rock by men working in the interior chambers as described in The Engineering Record of February 2nd.



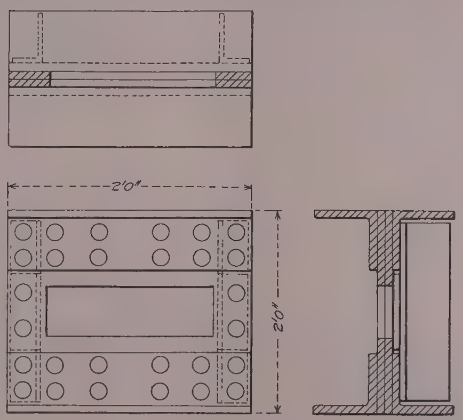
Connection of Anchorage to Column.

Eight of the piers, indicated in the accompanying diagram, were provided with vertical steel anchorages extending nearly to the bottom and built in as the concrete was made in such a manner as to utilize the full weight of the pier, estimated at 1,150,000 lb. in the maximum case, besides the very large indeterminate friction between the sides of the pier and the earth, to resist the upward reaction of 925,000 lb. The adhesion of the pier concrete to the steel anchor rods, assumed at 50 lb. per square inch, was utilized in designing the anchorages. The rods were, accordingly, not made of the same cross-section throughout their entire height, but decreased gradually toward the bottom, on the assumption that the lowest section of rod pulls on the lowest part of the pier only, the next section above that takes its share in addition to the part below, and so on, the uppermost section of rods taking the entire pier.

The anchored columns, like all others in the tower, have rectangular closed cross sections made with pairs of channels and cover plates with base plates bolted to cast-steel pedestals seated on grillages which distribute the column loads over the tops of the concrete piers. They differ from the other columns only in the anchorage connections which are made with cast-steel saddles engaging the upper ends of vertical plates riveted across the flanges of the columns. The anchorages for the different columns are similar, varying only in length and cross-sectional area. Each consists of a horizontal bearing piece bedded in the concrete near the bottom of the pier and connected to a vertical chain of flat bars pin-connected together and to an upper link consisting of vertical rods with screw adjustments connected to the lower ends of the columns.

The anchorages for six of the columns are about 50 ft. long over all, for two of the columns they are about 48 ft. long and for the remaining three columns they are about 42 ft. long. The two longest sets are made with three 10-ft. panels of straight flat bars, one panel of bent flat bars and one panel of screw rods. The shorter panels differ from them in the omission of one panel of straight flat bars.

The bottom piece is made with two horizontal ¾-in. plates, 24 in. square, with two opposite edges stiffened with pairs of 6 x 6-in. flange angles and the other two edges stiffened with single 5 x 3-in. angles riveted to the upper side. In the center of the rectangular thus formed there is a slot 16½ in. long and from 4 to 6-in. wide through which the ends of the lower anchor bars pass, engaging a 6½-in. horizontal pin P 8, 20 in. long, with bearing on the flanges of the side angles. In the anchorage for column 29, this pin engages a 15 x 1 1/16-in. bar, B1, 11½ ft. long over all, made with two pieces riveted together and having their ends reinforced to a thickness of 2 15/16 in. and bored for 6½-in. pins.



Anchor Plate.

The upper end of this bar is connected to a pair of 15 x ⅞-in. bars, B2, 12 ft. long over all, each made with a single piece and receiving at the top a 6½-in. pin, P15, with a shoulder at one end and a cotter at the opposite end which engages three bars, B3, that are in turn connected by the upper pin, P1, to a set of four bent bars, B4, each made with a 16 x 9/16-in. plate reinforced at both ends to a thickness of 1¾ in. for the pin-bearing and having a 6 x 1-in. notch in each edge of the upper end to clear the slot in casting S5, which encloses them and affords bearing for the nuts on the lower ends of the vertical adjustment rods, R1. This casting is flanged on the under side to resist the bending moment and is planed on the horizontal upper face to give bearing for the top casting S1, which has a half-hole bearing for pin P12, through the upper ends of the anchor bars.

The four 4½-in. vertical adjustment rods, R1, pass through a cast-iron plate, C, just below the grillage beams and pass between the webs of the latter through notches cut in their flanges. The upper ends of the rods clear the column pedestals and base plates and passing close to the columns between their lower wing plates engage the flanged cast steel saddles C2, seated on the upper edges of the latter, and take bearing on them with double pairs of nuts. The other anchorages are similar to this one except that in three cases the 3-bar panels of straight bars are omitted and there are only three pieces in the upper panels of bent bars. In construction the bars were bedded in the concrete as the piers were built and after the caissons were sunk and the columns were seated permanently on their grillages and connections between them were made by bringing the upper nuts to bearing on the column saddles.

Mr. Ernest Flagg is the architect of the building, the structural work was designed by his engineering staff; Messrs. Bolles & Hodge are the consulting engineers; Mr. O. F. Semsch, chief engineer. The contract for the fabrication and erection of the structural steel was awarded to Milliken Brothers, who are now erecting it.

The Rutherford Gravity Yard of the Philadelphia & Reading Ry.

On account of the great increase of traffic and delays due to inadequate terminal facilities at Harrisburg, the Philadelphia & Reading Ry. Co. determined in 1900 to establish a terminal yard at Rutherford, about five miles east of that city. The ground at this point was favorable and the grade of the railway descended in both directions at the rate of one-half of 1 per cent. toward Harrisburg and toward Reading. The work was started and a yard of moderate capacity put in operation about the close of that year.

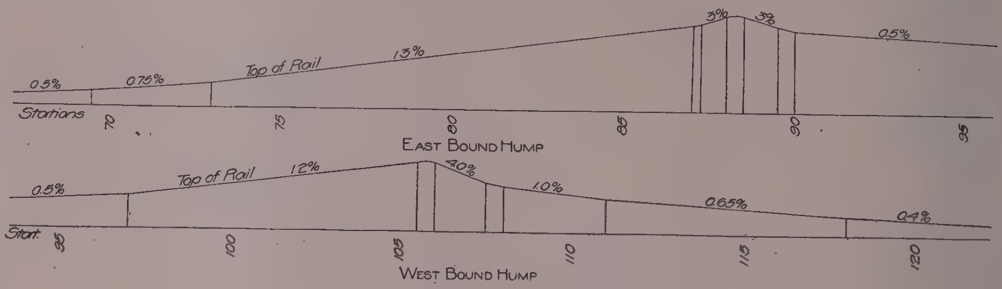
The business continuing to increase, it was determined in the fall of 1904 to expand the Rutherford yard largely, and rearrange it so as to provide a gravity freight classification yard that would be sufficient to handle the then existing business, and also provide for future increases. A study of the traffic and its probable increase showed that it was necessary to have a much larger capacity for the east-bound classification yard than for the west-bound, and the greater number of empty cars west-bound than east-bound caused differences in the design of the hump grades. Another early decision in the matter was to separate the passenger entirely from the freight traffic, and to do this the main tracks were spread at the yard site, one being placed on each side of the yard. The location of the existing tracks, roundhouse, coaling station, and other structures, influenced the design to such an extent that the engineers of the railroad do not regard it as ideal, but merely the best under the governing conditions.

The total length of the yard between the interlocking towers which control all movements out of or into it is about 3⅓ miles, and the greatest width about 900 ft. Both departure yards lie outside the territory of maximum train movements, while the receiving yards are placed alongside the classification yards of the opposite bound movement. Between the two classification yards are the shop car tracks, engine tracks, coaling station and round house.

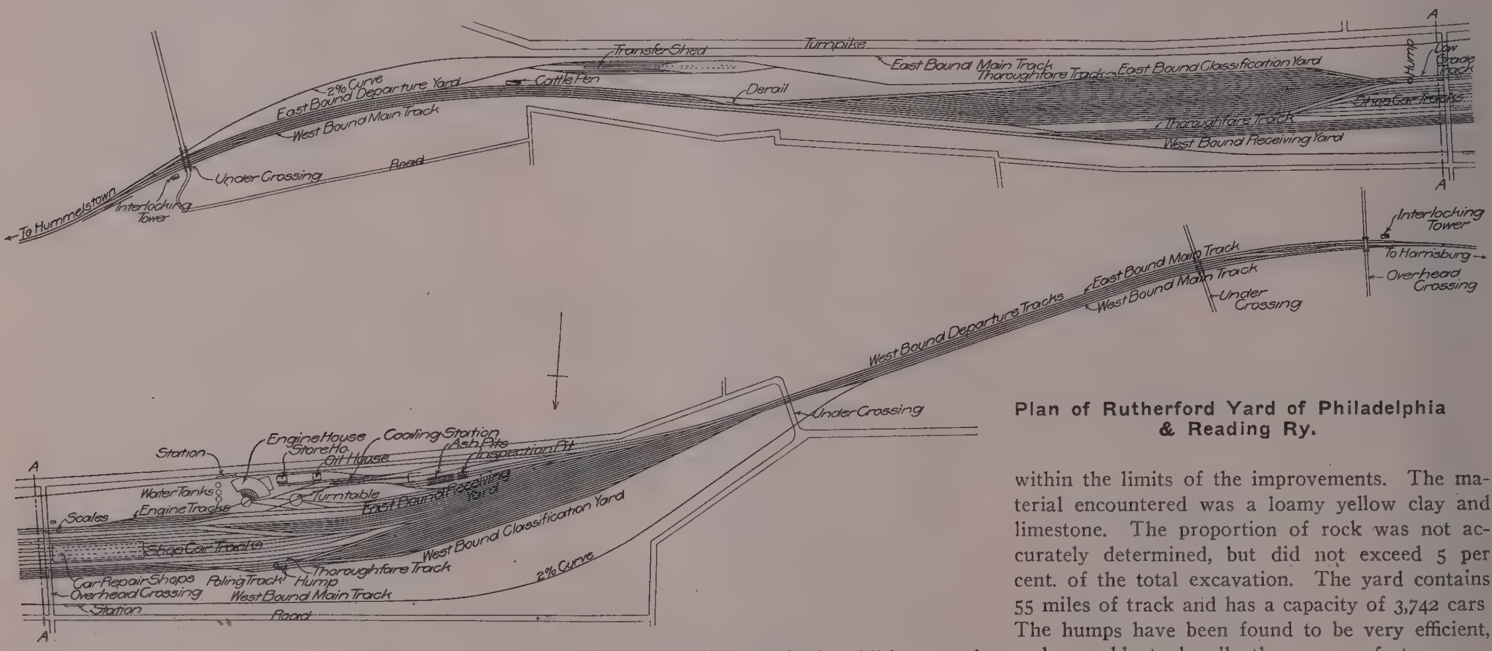
An east-bound freight train on entering the yard drops its caboose on one of the tracks provided for the purpose, and then proceeds to the east-bound receiving tracks, six in number, which cover practically the whole of the former yard. The engine is at once cut off and proceeds to the ash pits, inspection house, and then to the roundhouse. The cars are inspected and marked for classification. A thoroughfare track is maintained throughout the whole yard, so that if desired a train of perishable freight or live stock can be taken to the departure yard or transfer sheds without passing over the hump and through the classification yard.

When a train is ready to be broken up, a memorandum of the cuts is handed to the switchmen at the hump, two engines are coupled behind the train, and the work of classification begins. Twenty-three tracks are used for this purpose and an extra track is used as a thoroughfare track. About 25 car riders are employed to control the cars, and they are picked up and returned to the hump by an engine running on the thoroughfare track. The movement of the trains over the hump is controlled by hand-worked semaphores, and when these are not visible to the engineers on account of the length of the train or the curvature in the receiving yard, the signals are given by means of compressed air whistles. The latter are operated by an electric current controlled through a switch at the hump. The entrance to the classification tracks from the hump is by means of four ladders, though but one ladder is used at the exit end.

When an engine is ordered out to move freight eastward it proceeds to the east end of the east-bound classification yard, hauls the train to the departure yard, and then out onto the main track, stopping long enough to receive the caboose. The tracks for the latter are on a 1½ per cent. grade, making it easy to start and push the caboose down to the waiting train.



Profiles of Humps.



Plan of Rutherford Yard of Philadelphia & Reading Ry.

The procedure for west-bound trains is identical with that just described, but in the opposite direction. The main variations in the two sets of tracks are due to differences in the character of the traffic in the two directions. The eastward traffic being the heavier and a greater number of classifications being necessary for the economical distribution of the cars to their destination, 23 tracks have been provided in the east-bound classification yard as against 13 in the west-bound yard. On the other hand the traffic westward consists of a great number of empty cars, which influences the train length. Both the receiving and departure yards, therefore, for westward movement have longer tracks than the corresponding yards for eastward movement. The hump grades have likewise been influenced by the differences in the traffic, those of the west-bound hump being the steeper on both sides of the hump. This is done because empty trains can readily be hauled up to the steeper grade, and because empty cars start harder and run harder than loaded ones. The starting grade eastward is 3 per cent. and westward 4 per cent. In order to compensate for the increased friction of the cars due to cold weather, the humps are raised in winter from 10 to 15 in.

There are eight shop car tracks in the center of the yard, with a capacity of 472 cars. They are easily reached from both receiving yards, so that bad-order cars can receive quick attention. Easy access from both yards is also characteristic of the plant for caring for the engines. The entire design has been so carried out that all movements, whether in the regular business of freight classification, or in the auxiliary work of caring for engines, moving bad-order cars, and hauling trains to the transfer sheds, can be carried on without interfering with each other.

The plant for caring for the rolling stock and engines has naturally required additions and changes in order to be able to handle the equipment required by the increased business. The car repair shop, now being built, will be 123 ft. wide and 602 ft. 10 in. long. The coaling station has been doubled in size, a new drop table built in the round-house, and a 75-ft. turntable, and two 175-ft. ash pits added. The latter are to be equipped with a mechanical ash-handling plant. A track scale is located on a track parallel with that leading to the east-bound hump. The transfer shed is 24 ft. wide by 600 ft. long, and is served by six tracks, three on each side of the shed.

The highways intersecting the yard have been either raised or depressed so as to eliminate grade crossings. Over the center of the yard a truss bridge has been built to carry the traffic and there are in addition three subways under the tracks. Two of the latter are steel-beam concrete box culverts, one having a 20-ft. span and carrying seven tracks, the other a span of 16 ft., carrying six tracks. In the other subway crossing, the tracks are carried on plate girder bridges, with ballast floors. The Lebanon & Harrisburg turnpike was deflected through one of the subways and a new highway opened along the north side of the yard. These road changes and crossings required 5,444 cu. yd. of concrete, and 23,132 sq. yd. of stone macadam.

SUMMARY OF TRACKS AND CAR CAPACITY.

		Each.	Total.
Eastward Yard:			
6 Receiving tracks		55 cars	330 cars
23 Classification tracks	Av.	65 "	1,495 "
3 Departure		65 "	195 "
Westward Yard:			
5 Receiving tracks............		75 "	375 "
13 Classification tracks.........	Av..	50 "	650 "
3 Departure		75 "	225 "
8 Shop car tracks.............			472 "
Total capacity			3,742 "

Construction was begun in June, 1905, and was finished in August, 1906. From two to five steam shovels were employed in moving 600,000 cu. yd. of unclassified material, which was all deposited within the limits of the improvements. The material encountered was a loamy yellow clay and limestone. The proportion of rock was not accurately determined, but did not exceed 5 per cent. of the total excavation. The yard contains 55 miles of track and has a capacity of 3,742 cars The humps have been found to be very efficient, and are able to handle the cars as fast as supplied. From 1,500 to 3,500 cars are classified daily by means of both humps.

The yard was designed under the direction of Mr. William Hunter, M. Am. Soc. C. E., chief engineer, and carried out under the supervision of Mr. Paul Voorhees, Assoc. M. Am. Soc. C. E., assistant engineer of the Harrisburg Division. The contractors for the grading and masonry were Messrs. Ryan & Kelley, Philadelphia, and Messrs. Smith & Campion, Mahanoy City, Pa. Mr. Enos L. Seeds, Philadelphia, built the turntable, ash pits and the addition to the coaling station, and Messrs. George W. Beard & Co., Reading, Pa., are building the car repair shop. Messrs. Armstrong & Latta, Philadelphia, built the freight transfer shed and signal towers; The Phoenix Bridge Co., Philadelphia, the turntable; Messrs. L. F. Shoemaker & Co., Philadelphia, the superstructure of bridges, and the Federal Railway Signal Co. installed the interlocking plants.

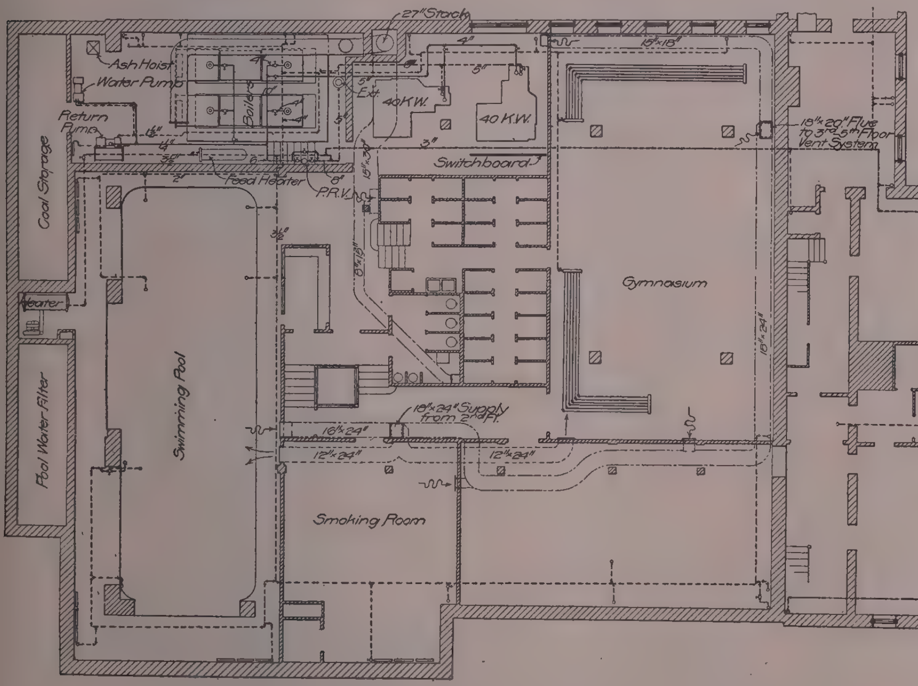
THE PANAMA CANAL EXCAVATION at the Culebra Cut during March was 815,270 cu. yd., the greatest record yet made. The total record for February was 638,644 cu. yd. and for January 566,750 cu. yd.

Heating and Ventilating the People's Palace, Boston.

The Salvation Army of Massachusetts has recently completed a five-story, 85x90-ft. building known as the "People's Palace, East Brookline and Washington Sts., Boston. It has the mechanical plant, a swimming pool, baths and a gymnasium in the basement, an auditorium seating 1,000 people, and stores on the first floor, several public rooms, offices and library on the second floor, and large numbers of 6x8-ft. sleeping rooms for cheap lodging on the three upper floors. As there are 97 of the sleeping rooms on each floor, all occupied every night, ventilation became a difficult problem.

The building is of steel and brick with reinforced concrete floors and roof. All partitions are of concrete, those between the small lodging rooms being of cast slabs. The main stair-well is enclosed in iron partitions with wire-glass and metal doors. An adjoining 28x90-ft. office building has been made a part of the new building by extending the front of the latter across it.

Mechanical Plant.—The boilers are in a 21x36-ft. room at one corner of the basement, adjoining a 19x25-ft. room for the electric units. Under one sidewalk there is a 6½-ft. space, of which 32 ft. is devoted to coal storage and 30 ft. to a filter, circulating and heating equipment for the water of the swimming pool, which is used over and over with only small amounts of fresh water added each day. Ventilation is provided by a 16x20-ft. roof pent house for fresh-air fans, and a 13x18-ft. penthouse for the exhaust fans. The boilers supply steam for heating the new and old buildings and for the electrical units which furnish current for lighting and running the fans.



Mechanical Plant in Basement of the People's Palace.

There are two 80-h.-p. horizontal return tubular boilers in a single setting at one side of the boiler room, facing the coal bunkers. They have 16-ft. shells 48 in. in diameter. They are designed for a pressure of 150 lb., although operated at 85 lb. They are fitted with asbestos protections for the blow-off connections where the latter pass through the line of the gases. The Sidney-Smith method of setting is used, with 48x48-in. New England shaking grates. The boilers were built by the Hodge Boiler Works, Boston, Mass.

About 60 tons of coal can be stored in the bunker, from which it is wheeled to the boiler room and fired by hand. Bituminous coal is used, as the boiler setting enables smoke to be prevented. Ashes are handled in cans by a small hoist lifting them to the sidewalk for removal by the city. There is a 27-in. steel stack which rises in a ventilation flue 40 in. square, to a point above the roof line, 92 ft. above the grate. The stack is of 3/16-in. plates in the upper half and ¼-in. plates in the lower half, at the bottom a ⅛-in. plate breeching 27 in. in diameter leads to 10x30-in. connections to the smoke box of each boiler. The breeching and boilers are covered with 1 in. of magnesia cement applied on wire netting so as to leave a 1-in. air space.

The boilers are fed by a 5¼x3½x6-in. Warren duplex pump with receiver, which is fitted with the Waters pump governor for automatic return of condensation from the heating system. The pump has a Crosby water relief valve, and delivers through a 15x72-in. Berryman feed water heater to a brass header on the boiler, from which 1¼-in. connections are made to each unit. The heater is rated at 50 h.-p. and mounted in an elevated position at one side of the boilers and utilizes the exhaust from the pumps and generating engines. The boiler feed branches extend through the front head 3 in. above the flues, back to within 2 ft. of the rear head and thence down to the bottom of the shell. The feed system is supplemented by a 1¼-in. Lee ball injector for use in place of the pump if desired. The latter is connected to draw either from the receiver tank to return condensation from the heating system, or from the city water main for make-up. The blow-off system consists of 2-in. connections tapped into pads on the lower side of the shell, 9 in. from the rear head, and lead to a 24x36-in. blow-off tank elevated 8 in. above the floor at the rear of the boilers. The blow-off lines are of extra heavy pipe with flange connections, and the boiler branches have each a 2-in. Pratt & Cady asbestos-packed cock and a Chapman 2-in. gate valve. The blow-off tank has a 2-in. connection to the sewer, arranged to maintain it always half full of water, and a 2½-in. connection to a vapor pipe carried 2 ft. above the roof level.

The steam piping has a 10-in. cast iron header over the boilers with 4-in. connections to rear nozzles on the shells and from this header steam is delivered by a 5-in. line to two electric units in the adjoining room and through a 6-in. line with a reducing valve to the heating mains. The engines have 4-in. branches each fitted with a direct horizontal steam separator. The heating connection has a 6x8-in. Waters reducing valve with 4-in. bypass connecting into an 8-in. heating header. As the exhaust steam from the engines and pumps is also utilized in heating a 6-in. exhaust connection from the former and a 1½-in. line from the latter are connected through a direct oil extractor to the heating header. For relief to the engines and pumps in case of back pressure in the heating system, there is a 6-in. atmospheric exhaust pipe running from the exhaust line, between the oil separator and the heating header, through the smoke stack shaft with a Davis relief valve near the roof. Condensation is drained by a 1-in. drip system connecting into the high-pressure header and the engine room main and leading to a steam trap that delivers to the condensation return tank. The oil extractor is drained through a trap to the blow-off tank, as are also the cylinder drips. All high-pressure steam and heating piping is covered with H. W. Johns-Manville asbestos fire-felt sectional covering, 1-in. thick, canvas jacketed and banded. The heating risers are covered with 1 in. of standard wool felt covering over asbestos paper, protected by an external layer of sheeting paper and canvas sewed on.

Heating.—The new building is heated throughout by direct radiation, all fresh air supplies to the interior being for ventilation purposes only and, therefore, merely raised to the temperature of the interior by tempering coils. The radiation is operated on the two-pipe system with gravity returns and utilizes exhaust steam at low pressure from the steam-using machinery. Two-column Peerless radiators 36 in. high and Colonial wall radiators are used. The radiation is supplied by fifteen risers in the new building and seven in the old building. In the new building eight risers supply radiation to the three lodging room floors exclusively and seven supply radiation on the second floor. All radiation on the first floor and basement of both buildings is supplied from the basement mains. Each lodging room floor has nine radiators of 284 sq. ft. of radiation, while the outer rooms on the second floor have in all twelve radiators with a total of 332 sq. ft. On the first floor there is 804 sq. ft. of radiation, while in the basement there is 317 sq. ft. distributed in the gymnasium, smoking room and swimming pool room. This, together with a 2-in. riser in a toilet vent duct 65 ft. high, for the purpose of creating a circulation, makes a total of 2,345 sq. ft. in the new building, which, with the 858 sq. ft. in the old building, makes a total of 3,3003 sq. ft. of direct radiation.

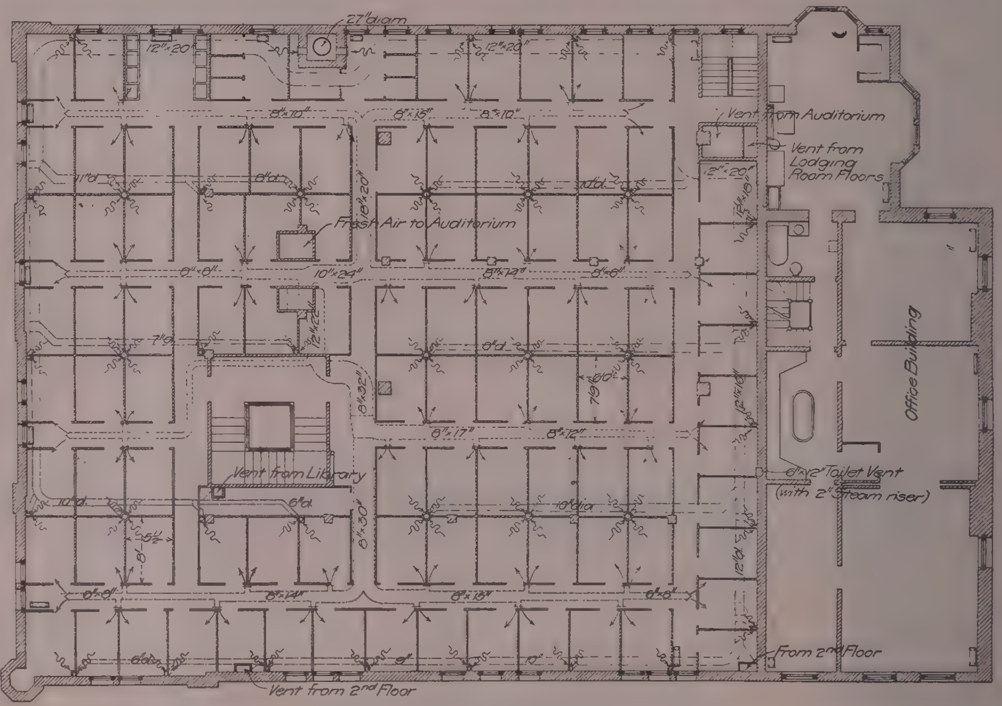
The low-pressure mains in the basement are a 4-in. and two 3½-in. lines for the new building, and a 3-in. line to the old building. The return gathering mains connect all first floor and basement radiators and the 23 return risers, and discharge by gravity to the return tank in the boiler room from which the feed pump delivers to the boiler under the control of a governor.

Ventilation.—The general scheme of ventilation provides fresh air to and exhausts foul air from the lodging rooms on the three upper floors, the Sabbath School rooms and library on the second floor, the auditorium and the basement rooms. The fans in the pent houses are electrically driven and so placed that it was possible to make direct connections from the fan to the vertical flues or shafts through which the air supply or exhaust connections were made. The air supply is filtered. The ventilation plant is operated in two divisions, one for the lodging rooms and the other for the public rooms on the lower floors; this is due principally to the fact that ventilation is required in the lodging rooms only at night, while in the other portions of the building it is needed only in the daytime or evening, although it was further desirable that the two services be kept separate owing to the peculiar conditions under which they operate.

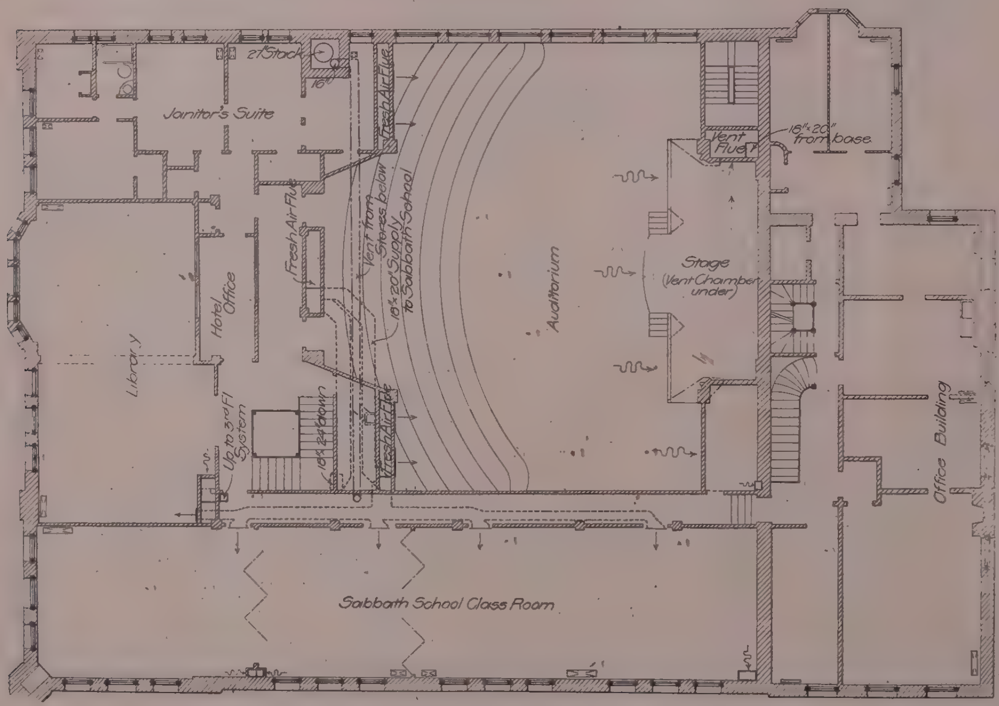
When all the sleeping rooms are filled there will be 96 lodgers on each floor, grouped in a 75x85-ft. room with 10-ft. headroom. The ventilating equipment is sufficient to change the air in each room approximately four times per hour. The fresh air ducts are on the ceiling, generally following the corridors, as shown in the accompanying plan, and have 56 delivery outlets on each floor which, for the greater part, serve two rooms each by blowing into the space above them at points opposite partitions. Foul air is removed from each room by a vent 4 in. above the floor, connected to a system of gathering ducts on the ceiling near the outer wall lines.

The 110-in. fans for the lodging room ventilation are both rated at 12,400 cu. ft. per minute each. The fresh air fan discharges directly downward into a masonry flue which is 30 x 48 in. in cross-section to the top floor, 30x36 in. to the fourth floor and 30x20 in. to the third floor. The successive changes in sections and the arrangement of duct connections are such as to divide the air delivered equally between the three floors, and as there are 56 outlets on each floor, the average delivery from each at the maximum capacity of the fan is 73 cu. ft. per minute at a velocity of approximately 300 ft. per minute. The vent fan is connected to the exhaust system on each floor through a galvanized iron duct in a masonry flue. The duct has a cross-section of 12 sq. ft. to the top floor, 10 sq. ft. to the fourth floor and 7 sq. ft. to the third floor; from the base of this duct there is also carried down an 18x20-in. connection to the basement for exhaust ventilation.

The exhaust ducts are arranged along the outer wall, with branches along the middle partition lines between the lodging rooms. The vent register branches extend down below the partitions, which are 4 in. above the floor, to intake openings in each room near the floor. The capacity of this system and the duct and register velocities of flow are approximately the same as those for the fresh air system. All supply and vent registers are covered with ¼-in. mesh galvanized iron wire screen, soldered in place and the branches supplying these openings are fitted with adjustable dampers which may be locked in any position.



Ventilation of Lodging Room Floors.



Ventilation of Auditorium and Public Rooms, Second Floor.

The ventilation of the auditorium and the lower floors is effected by two 100-in. fans located like those already described to connect directly to masonry flues 12 ft. square leading down to the connections on the lower floors. That for the fresh air leads to a plenum chamber below the elevated rear portion of the auditorium gallery, while that for exhaust leads to a large chamber under the auditorium stage. Both systems are principally for ventilating the auditorium, the exhaust system being without connection to any other portion of the building, although the fresh air connections are arranged so that the auditorium may be supplied exclusively, or a portion of the supply directed to the lower floors.

The fresh air, when directed entirely to the auditorium, provides for about 50 cu. ft. per minute to each member of an audience of about 1,000. The supply is furnished through eight 24x36-in. registers in the upper portion of the rear wall, four above the gallery and four underneath for downward supply. These registers are connected to the plenum chamber underneath the gallery floor by enclosures behind the wall of sufficient size to reduce the velocity of flow from the registers to not over 300 ft. per minute. The exhaust ventilation chamber utilizes a large space under the stage, in all of the front and lateral faces, of which there are openings. The openings are 20 in. high and covered with ornamental gratings which have a total length of 32 ft., so that a low velocity is assured. The exhaust system has the same capacity as that for the fresh air supply to the auditorium, but is used exclusively for the auditorium, the ventilation of all lower floors being accomplished by the system which serves the upper lodging-room floors.

Fresh air is supplied to the Sabbath School rooms and library on the second floor and to the basement by a branch of 5 sq. ft. from the auditorium supply flue, which divides into a 12x30-in. duct to the second floor rooms and an 18x24-in. flue to the basement. The former leads to a distributing duct over the hall between the auditorium and class rooms, with four 12x24-in. outlets into the class rooms, and a 15x24-in. outlet into the library. These registers are near the ceiling and designed for air velocities of about 300 ft. per minute. The basement receives about 3,000 cu. ft. per minute at the maximum capacity of the fans. This is divided equally between the swimming pool room and the gymnasium. The registers there are also near the ceiling and are proportioned for air velocities of about 400 ft. The ventilation of the basement is mainly accomplished by the system which ventilates the lodging room floors. This is operated continuously, but it is supplemented to a limited extent by natural ventilation accomplished by the flue enclosing the smoke-stack from the boiler plant. An 18x20-in. flue is dropped from the third floor exhaust system to the rear of the gymnasium, from which branches extend to either end of the gymnasium and from the latter point to the swimming pool room. The gymnasium has a 15x18-in. vent register at the base of the riser and two 18x18-in. registers at opposite ends. The extension to the bathroom has a 24x24-in. vent register in the latter and also an 18x18-in. register into the smoking and lounging room adjoining. These registers are at the floor and are proportioned to remove volumes of air from these rooms approximately equivalent to those supplied by the fresh air system.

The natural ventilation is created by the heat of the smoke stack in its shaft, and is used for the boiler room, the basement corridor and the toilet room in the basement. There is a free area of about 7 sq. ft. between the shaft and the stack. Opening into this is a register 24 in. square from the boiler room and a 15x30-in. duct on the engine room ceiling which extends to a group of two 18x36-in. registers in the corridor, one at the ceiling and one at the floor, with an 8x15-in. branch to a toilet room off this corridor. Two connections are made to the flue at the second floor level, for exhaust from the toilet rooms of five stores on the ground floor and one on the second floor. These two branch exhaust ducts join into a single 16-in. circular duct which extends up within the shaft enclosure to about the third floor level, to prevent the possibility of back draft into the rooms ventilated. On the third, fourth and fifth floors there are vents into the shaft from toilet rooms on the lodging room floors; these are 12x12-in. registers on ceilings and floors on two sides of the shaft, fitted with diaphragms within the shaft to prevent back draft into the rooms. Further supplementary ventilation is afforded for a group of toilet rooms in another part of the building by a 6x12-in. vent flue built into a chase in the wall separating the new and old buildings. This flue is connected by two 6-in. circular ducts at its base to the toilet room of a store and a toilet room off the auditorium stage, while on the second floor there is an 8x8-in. register from a toilet room. This flue is operated by draft induced by a 2-in. pipe carried up about 60 ft. to the roof outlet and supplied with steam from the heating system.

Both fresh air fans have sectional hot blast heaters of the positive circulation pattern in their intake openings, that for the larger fan having 450 sq. ft. of heating surface and a free air space between the pipes of 14.2 sq. ft., while that for the smaller unit has 460 sq. ft. of surface and presents an air space between pipes of 10½ sq. ft. The fans and heaters were supplied by the Green Fuel Economizer Co., and are driven by 110-volt standard Crocker-Wheeler motors fitted with Cutler-Hammer starting boxes, so connected that the motors may be stopped or their speed regulated from the engine room.

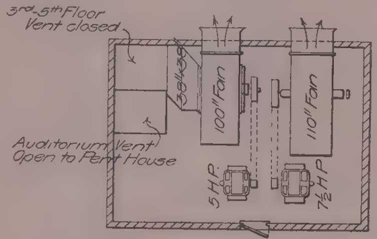
The air supply for the fans is admitted to the pent house through a cheese-cloth filter having nearly 1,500 sq. ft. of surface. It consists of 90 cheese cloth bags, 12 in. in diameter by 5 ft. long suspended from a horizontal diaphragm of No. 20 galvanized iron. The diaphragm stand is surrounded by a galvanized iron enclosure and covered by a canopy with overhanging hood, which causes the air taken in to enter above the diaphragm plate and pass through the cheese cloth bags into the pent house enclosure. The bags are mounted on collars projecting downward from the openings in the diaphragm plates, to which they are strapped from below for ease of removal for cleaning. The filter has been installed on the Woodbury system and provides for a filtering velocity not to exceed 20 ft. per minute at the full capacity of both fans.

The exhaust fans in the other pent house have similar driving equipments and motors and are operated at the same speed. The 100-in. fan which draws from the three upper floors, has a direct duct 38 in. sq. to the duct from the lodging room exhaust systems in the large shaft. The other fan has, however, an intake through the pent house enclosure, the exhaust shaft from the auditorium opening directly into the pent house.

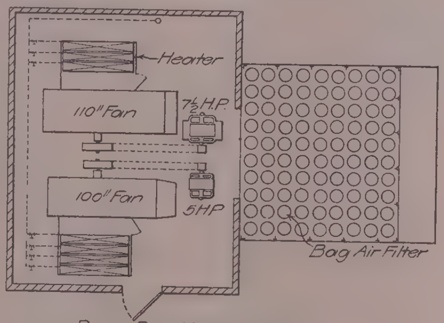
Electrical Equipment.—There are two 40-kw. direct-current generating units with McEwen simple horizontal automatic engines built by the Ridgway Dynamo & Engine Co., to which the Bullock generators are direct connected. They have 11x12-in. cylinders and operate with a steam pressure of 85 lb. at 300 r.p.m. They are designed for operation against a back pressure of 5 lb., their exhaust being utilized in the heating system of the building.

The circuits are controlled by a switchboard having four panels of 2-in. slate slabs, 24x79-in. in size. Two are for the generators and contain a voltmeter and ammeter, the generator rheostat, a three-pole main switch and a 400-ampere Eldon type, double-pole circuit-breaker. The feeder panel provides for eleven three-wire circuits for lighting and eight two-wire circuits for motors. The lighting circuits are arranged in general with separate feeder circuits to each floor, with separate feeders to the auditorium, the old office building, an adjoining group of stores supplied, the roof garden, and an electric sign.

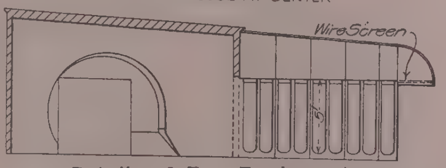
Water Supply.—An interesting feature of the building is the swimming pool and the provisions made for water supply. The pool is an 18x56-ft. tank 4½ to 6 ft. deep. Instead of continually renewing the water in the pool, only a small amount of fresh water is added each day and the water is refiltered daily through a mechanical filter by means of which it is kept clean and clear, and, as the water is recirculated, it is kept warmed to the proper temperature. The filter has been installed by the Swimming Pool Filtration Co., of Boston, and occupies a 6½x24-ft. vault space, as before stated. It is fitted with troughs for distributing the water from the pool equally to all parts of the filter bed and aerating pipes for passing compressed air through the bed, while washing it. The water is raised to the filter by means of a Warren duplex steam pump, and flows back to the pool by gravity through a hot water heater. The steam supply for this heater is taken from the low-pressure heating system and is under thermostatic control. The water in the pool is maintained in a very clear and cleanly condition, and it is not changed for a period of a month or more at a time, except that a little fresh water, not over one inch in the pool, is added each day.



PLAN – PENT HOUSE AT REAR OF ROOF



PLAN – PENT HOUSE AT CENTER



Details of Fan Equipment.

Well water is supplied to the pool, shower baths and closets. It comes from a driven well 2 in. in diameter, extending down 80 ft., in which the water rises to within about 6 in. of the basement floor, so that the pump has but a very slight lift. The water as it comes from the well contains silt, iron and salt, the last due to the fact that the building is located on very low ground not far from sea water. The well is pumped by a 6x4x6-in. brass fitted duplex pump in the boiler room, which raises the water to a 5,000-gal. pine tank on the roof. This is done principally to aerate the water in order to oxidize the iron preparatory to filtration. The water is delivered from this roof tank to the plumbing system through two Loomis-Manning filters. The silt and color are removed, and the percentage of salt is so low as to be scarcely noticeable in the pool or shower baths.

The new building was designed by Messrs. Brainerd & Leeds, of Boston. The Richard D. Kimball Co., of Boston, acted as engineers for the entire installation, including power plant, heating and ventilating equipment, and electrical installation. The heating and ventilating equipment was installed by the Bradley & Chatman Co.

Crushing Old Building Materials.

In the rebuilding of San Francisco methods of economical leveling and construction have been practiced to a greater degree, probably, than at any other time and place. A typical instance is the work done on the Crocker Building, standing at the corner of Post and Market Streets. This structure, which is ten stories in height, with a frontage of about 200 ft., escaped any serious damage from the earthquake, but was gutted by fire. The frame of the building being intact, nothing more was necessary than a reconstruction of its interior, and the contractors hit upon the profitable plan of utilizing for concrete mixture all bricks, tiling, stone work and flooring which had to be removed. Suitable apparatus was, therefore, installed, and, as fast as the work of tearing down made this material available, it went directly to a Gates breaker fed from bins supplied by chutes from various sections of the building. After being crushed to the desired fineness the product of the breaker passed to a mixer, and as the concrete issued from the latter it was taken by a system of elevators and conveyors to all parts of the building where needed. The significant feature of this process lies in the fact that, from the moment the material was taken from the walls and floors until the time it again became a part of the structure, there was not the slightest break or loss in its handling.

An installation similar to this, but of relatively greater importance because on a larger scale, was made by Allis-Chalmers Co. at Chicago, when the old Cook County Court House was dismantled. This temporary crushing plant, purchased by the contractors in charge of the work, J. A. McMahon & Co., of Chicago, consisted of two breakers, an elevator and a revolving screen, all driven by electric motors. There was a breaker for doing the first crushing and one for handling rejections. The two were set together on the same level and discharged into an elevator measuring 49 ft. between centers, which conveyed the material to a dust-jacketed iron frame screen having 1½-in. perforations. The stone was reduced to 1¼-in. size for concrete, and the dust sold for use with it in place of sand. The oversize material was discharged on a belt conveyor, which carried it back to where it was fed into the smaller breaker. The plant was located in the center of the building, where it was easy of access for handling the stone as fast as the building was torn down. The crushed product was discharged into bins placed directly under the screen, from which it could be readily loaded into wagons. The contractors found this plant a profitable one, as they were able to sell the crushed rock right in the center of Chicago; in fact, towards the close they did not remove any of the material from the premises, but disposed of it to the firm putting up new structure.

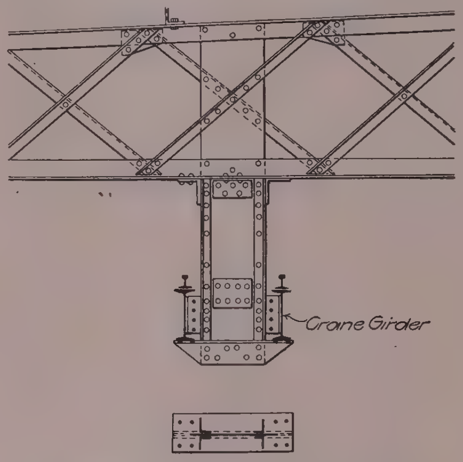
An Electrically Operated Structural Plant.

A plant for the fabrication of ornamental and structural steel work for buildings and bridges is now being constructed at Ravenswood, N. Y., on Long Island, opposite Blackwell's Island. It occupies the whole of a 200x700-ft. plot fronting on the East River, which has been dredged to a depth of 10 ft. at low tide and provided with a pier 200 ft. long and 40 ft. in minimum width. The shore end of the property has been graded to a level with the pier for a distance of about 125 ft. back from the bulkhead line, and from this point to the Vernon Ave. front the entire plot has been graded to a level 25 ft. above the dock level and 5 ft. above Vernon Ave. on the east front of the plot. Heavy stone retaining walls are being built to sustain the upper bench of earth and rock.

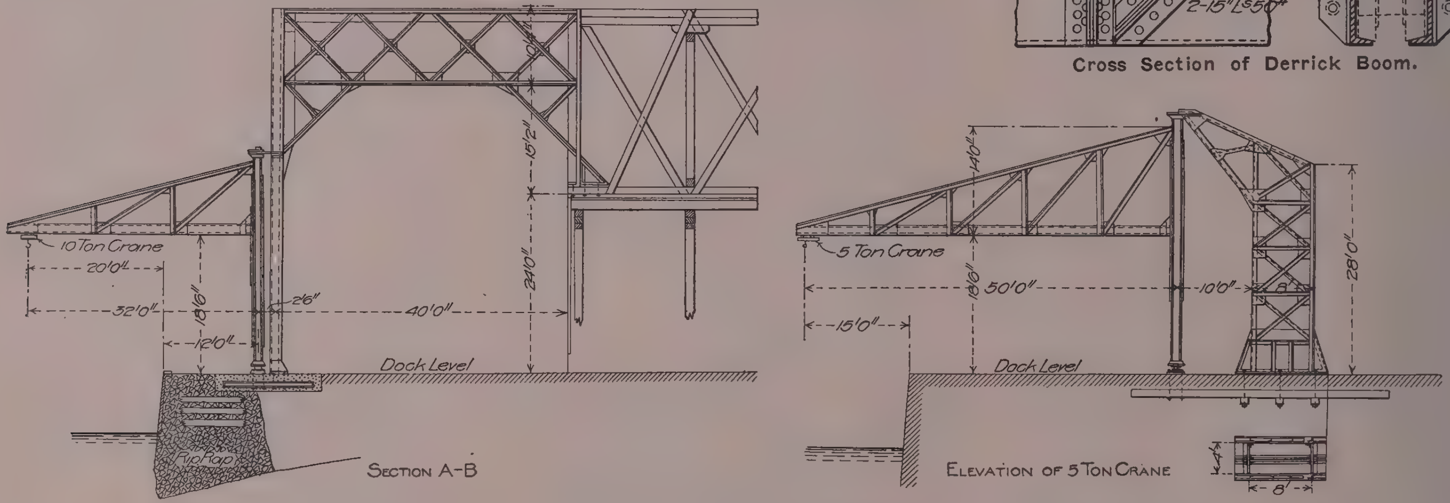
The dock level portion of the plot is partly covered by a two-story finishing shop, about 90 x 160 ft. in size, in which will be fabricated the light ornamental iron work. This shop has a heavy flat roof, serving also as a deck, forming a continuation of the upper part of the yard, and as an approach and shipping yards for the main riveting shop, 102 ft. wide and 240 ft. long, adjacent to the finishing shop. In the rear of this building there are several wooden buildings serving as template shops, rigging sheds, stables, storehouse, office, and the like. The remainder of the lot is used for receiving, storing and shipping materials, and includes a 30-ft. strip running the full length of one side and reserved for a public street if it proves necessary to provide one in the future.

There is an entrance for teams from Vernon Ave. at the shore end of the lot, but nearly all supplies, materials and finished products are to be received and delivered from lighters, to and from which they are handled by electric traveling cranes of 54 ft. span and 10 tons capacity with tracks extending 473 ft. back from the water's edge and carried on one side by the wall of the main shop. The cranes are 50 ft. above the pier, giving abundant clearance over the flat roof of the finishing shop. They travel far enough past the shore end of the main shop to command a large part of the storage area reserved there and to deliver to a transverse track. The latter is intersected by three lines of longitudinal standard-gauge track connected to it with turntables and running through the full length of the main shop and over the roof of the finishing shop. They are intersected inside the shop and on the flat roof by two transverse tracks with turntables, and also connect with a fourth longitudinal track which does not extend into the rear part of the yard. Besides being served by the traveling cranes, the entire area of the pier is commanded by two jib cranes. One of them has a radius of 50 ft. and a capacity of 5 tons, and the other a radius of 32 ft. and a capacity of 10 tons. The latter crane is connected and braced to the crane runway structure.

The main shop is divided transversely into a laying-out and punching shop 140 ft. long at the shore end, and a riveting shop 100 ft. long at the river end. In the punching shop, six longitudinal lines of 12-in. I-beams are secured to the lower chords of the roof trusses and each of them is equipped with two 3-ton electric trolley hoists. The riveting shop is provided with five sets of longitudinal tracks, each of them equipped with two 5-ton electric cranes of 17 ft. span, which together serve all of the floor area except a narrow strip on one side. At the end of the punching shop nearest the riveting shop, the longitudinal trolley tracks are connected over the surface tracks by movable transverse beams for 3-ton electric trolleys intended to handle material on and off the service cars. At the shore end of the punching shop, the three last roof trusses are provided with transverse trolley tracks on their lower chords, equipped in each of the two panels thus formed with two 3-ton electric cranes of 20-ft. span. It will be seen that the arrangement provides for the receipt of material from lighters, its transfer by yard cranes to the full length of the storage yard, its distribution and delivery to the surface tracks and by the transverse tracks, and its distribution through the laying-out shop in the shore end of the main building by the transverse over-head electric cranes. Hence the delivery of the material is almost entirely longitudinal until it reaches the surface tracks on the roof of the finishing shop and is passed to the revolving derricks which load it on lighters.



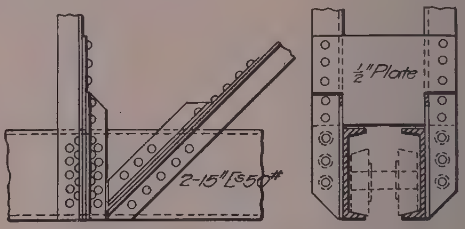
Support of Shop Crane Runways.



Cranes on Dock at End of Shops.

The main shop has four longitudinal lines of steel columns dividing it into three parallel aisles 34 ft. wide. The columns have I-shaped cross-sections made of four angles and a web plate, and are arranged in transverse bays 20 ft. apart. Their upper ends are web-connected to the lattice-girder roof trusses, 4 ft. 9 in. deep in the center, from which their top chords slope in both directions about 1:24. Their top and bottom chords are pairs of 5x3½x7/16-in. angles, and the web is made of single X-brace angles. On the center line there is a wooden monitor 5¼ ft. high and 18 ft. wide with pivoted louvre windows. The inclined top chords of the roof trusses support 3x10-in. wooden purlins, covered by 1-in. plank sheathing and a gravel and tar roof. The walls of the building are sheathed with wooden boards and are liberally supplied with windows.

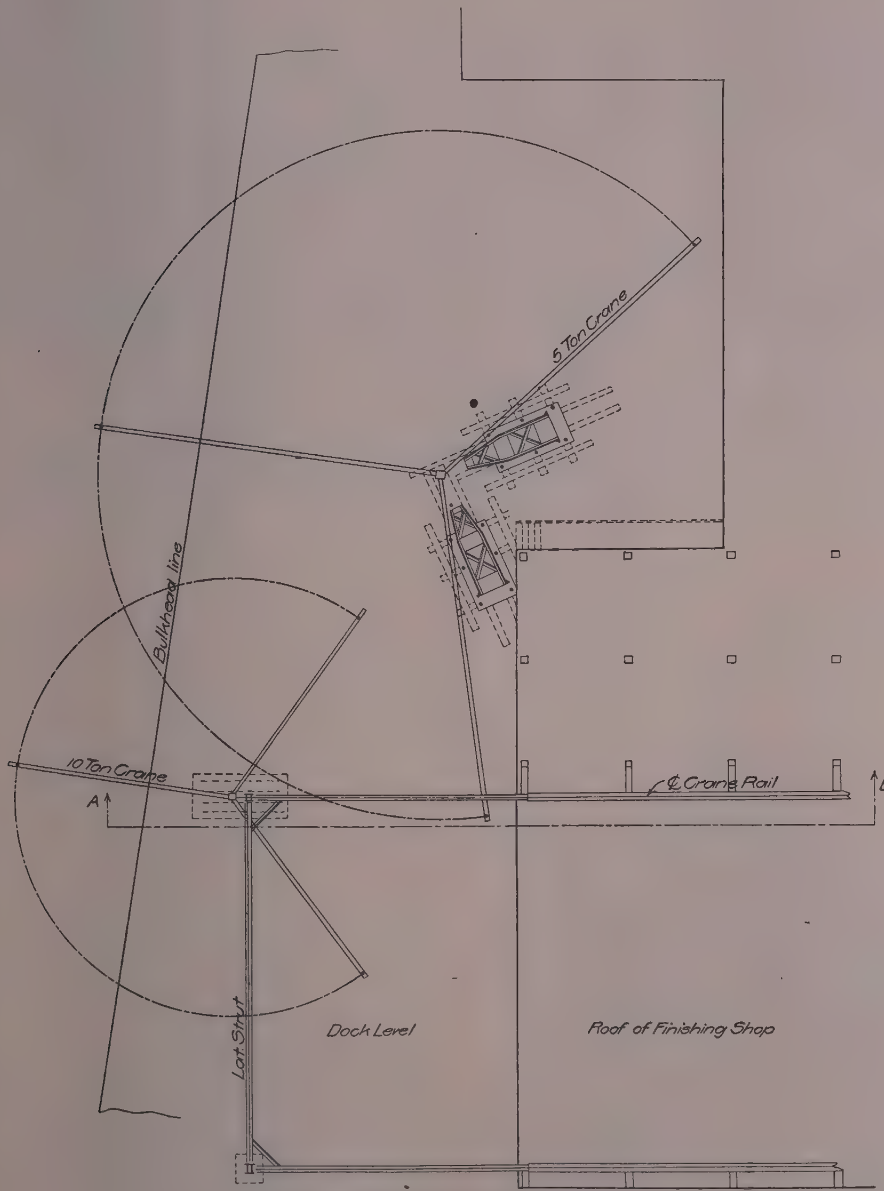
The runway girders for the shop electric cranes are seated on horizontal bracket angles riveted across the lower ends of web plates projecting below the lower chords of the roof trusses and riveted between the chord angles of both the top and bottom chords.



Cross Section of Derrick Boom.

The ornamental shop is of mill construction, with columns 15 ft. apart longitudinally and transversely. A portion about 50 ft. square at one end is reserved for a two-story boiler and engine-room, and the remainder of both upper and lower stories is occupied by light machinery and work benches. All of the columns have concrete pedestals flush with the lower floor; in the first story they are 12x12-in. timbers, having cast-iron caps to receive the second floor columns and girders, the latter being spliced across the columns by pairs of steel side plates bolted on. The first floor is laid directly on the surface of the ground; the second floor has 12x16-in. yellow pine girders supported on the column castings and carrying 3x10-in. floorbeams 15 in. apart on centres, covered with 2-in. floor planks. The 10x10-in. second-story sections of the columns have cast-iron caps supporting 10x12-in. corbels about 7 ft. long. The corbels give bearing to the 12x20-in. roof girders, each made of two 10x12-in. timbers laid flat. The girders carry 3x12-in. roof beams 15 in. apart, covered with 3-in. roof planks, planed on top and edges and covered with five-ply asphalt roofing laid hot. On this there is 1½ in. of cement concrete, 6 in. of cinder concrete and 1½ in. of sand and cement concrete for a finished roof surface.

The 10-ton jib crane has a vertical mast about 30 ft. high and a concrete and pile foundation. The trunnion at the upper end is pivoted under the river end of the last runway girder. Above the crane the top of this mast is braced longitudinally by the lattice girders carrying the crane tracks across the piers to the wall of the finishing shop, above which the track is continued with wooden girders on X-braced wooden columns, as shown in the detailed sketch. The mast of the 5-ton derrick is seated on intersecting pairs of wooden sills, buried about 2 ft. below the surface of the ground and supporting at their opposite ends the stiff legs of the derrick. The trunnion at the top of the mast engages cantilever arms projecting from the top of wide vertical posts or stiff legs set 7 ft. clear of the girder mast. These posts are made very stiff, being in fact small towers, with 4 x 8-ft. rectangular cross-sections. They are 28 ft. high on the short side and have four angles latticed on all four faces. They have extended riveted pedestals at the ground level which are anchored to the sills below. The jibs of both derricks are substantially alike and are pairs of 15-in., 50-lb. channels with their flanges turned inward and supporting the hoisting trolley. The inclined top chord of the jib for the 10-ton crane is made of two 6x6x⅝-in. angles latticed, and has a maximum strain of 74,000 lb. The top chord of the 5-ton crane has the same cross-section and has a maximum strain of 68,000 lb.



Boom Derricks on Dock.

All machines in the shop will be operated by individual electric motors. At first these will be driven by two-phase alternating current purchased from the local electric light company, but provision is made for the future installation of a plant to generate current if deemed advisable. The principal items of plant at first installed will include two Ingersoll-Rand air compressors; ten Allen pneumatic riveters and a number of standard machines from the Cleveland Punch & Shear Works, besides machine tools transferred from other shops of the same owners. The new tools will include five beam punches, one coping machine, one 48-in. multiple plate punch, one 48-in. plate shear, one plate straightening roller machine, one special angle punch, one angle shear, two 50-in. rotary planers, one of them with a revolving table, one angle straightening machine, and a supply of pneumatic hammers, reamers and drills from the Chicago Pneumatic Tool Co. The twenty 3 and 5-ton shop cranes are from the Reading Crane Co., and the 10-ton yard cranes are from the Northern Engineering Co. The 5 and 10-ton swinging jib cranes are built in the shop.

It is expected that the ornamental shop will have a capacity of $300,000 worth of work per annum and that the structural shop will be able to turn out 2,500 tons of finished product monthly. Grading was commenced at the site last November and it is expected that the buildings will be occupied in July with a force of about 200 men. The buildings were designed and the equipment selected and located by the engineering department of the owners, Messrs. Ravitch Bros., whose offices are at 81 Mangin St., New York.

A Tall Reinforced Concrete Lighthouse.

A very tall lighthouse has recently been constructed with great rapidity on the Point De La Coubre, at the mouth of the Gironde River, France, where sudden erosion by the sea threatened the existing lighthouse. The new one, about 225 ft. high over all, was accordingly built a little farther inshore at a total cost of about $90,000, and put in service within nine months from the date of commencement. The new structure is a tapered cylinder of reinforced concrete 35 ft. in diameter at the base and 192 ft. in height from the base to the focal plane. It has two lanterns, one at the top and another 118 ft. above the base, and has no interior openings except the circular stair-well 11½ ft. in diameter, and the service room. An external annular gallery below the lantern is supported on radial concrete brackets. The circular main walls of the shaft are about 2¼ ft. thick at the top and are battered uniformly 2.6 per cent. to a thickness of 5 ft. 10 in. at 47 ft. above the base, where the batter increases to 35 ft. at the footing, which is 11½ ft. deep and 52½ ft. in diameter. This reduces the maximum pressure to 3 tons per square foot on the sand, 7½ ft. above high water.

The lantern room floor is carried on steel beams and the walls of the shaft are reinforced near the outer face, by vertical and horizontal bars 0.4 in. in diameter and 8 in. apart on centers embedded in 6 in. of rich concrete surrounded by concrete made about 1 part cement to 6 parts of mixed sand and gravel. The tower was proportioned for a dead load of 149 lb. per cubic foot of concrete, and for a wind pressure of 56 lb. per square foot of vertical surface. The maximum compression on the concrete is about 8.7 tons per square foot.

The machine-mixed concrete was delivered by an endless-rope incline to the foot of the tower and hoisted in steel buckets handled by a mast and boom derrick in the center of the erection platform. The platform was carried by six radial horizontal lattice girders 35½ ft. long supported on the steel inner forms for the shaft. It had a light conical roof with an angle iron frame-work and from it was suspended an annular outside scaffold and a circular interior scaffold below the bottom of the inside form. The inside form was made of four courses of steel shutters with interior flanges and the exterior form was made with six courses of wooden shutters 26 in. high and 1⅝ in. thick, with their upper and lower edges rabbeted to overlap and tightly bound together by ⅜-in. horizontal wire ropes with turnbuckle adjustments. As fast as the concrete walls were built up close to the under side of the platform, jack screws were set on them and lifted the platform high enough to release the interior steel shutters and allow the lower course to be removed and placed on top of the upper course, after which the platform was lowered to bearing on it again and the lower course of external shutters was also raised and set on top of the upper one, and so on until the work was completed. The shutters were removed after the concrete was three days old. The tower settled about 0.4 in., and during a heavy gale a few months after its completion the oscillations recorded by an automatic instrument did not exceed 0.08 in. and had a minimum period of 0.71 seconds. The design and construction were described in a recent issue of "The Engineer," of London.

The New Water Works at Wilmington, Del.

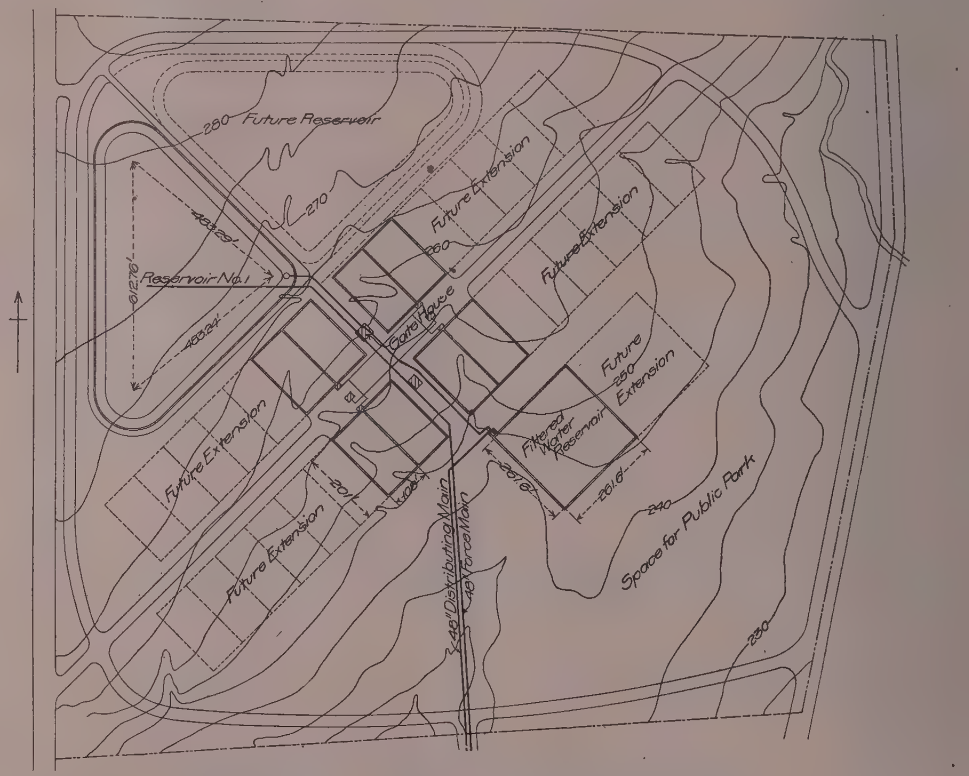
The new works with which Wilmington, Del., is to be furnished with filtered water from Brandywine Creek include a pumping plant rated at 24,000,000 gal. per day against a head of 285 ft.; a 15,000,000-gal. preliminary filter of the Maignen type, with some innovations; a 35,000,000-gal. concrete and puddle-lined sedimentation reservoir; 8,903 ft. of 43-in. lock-bar steel force main connecting the pumping station and the reservoir; 10,448 ft. of 48-in. lock-bar steel distributing main connecting the reservoir to the present low-service reservoir and the high-service distribution system; and a reinforced-concrete arch bridge to carry the 48-in. pipe over Brandywine Creek and connect two parks, one on each side of the stream. These works are now under construction and will, when completed, require a total estimated expenditure of about $430,000. In addition plans have been prepared and bids will soon be asked for the construction of a slow-sand filtration plant with a daily capacity of 15,000,000 gal. together with a 10,000,000-gal. filtered water reservoir.

Brandywine Creek originates in Chester and Delaware Counties, Pennsylvania, and about 18 of its 30 miles of length are in that State. Above Wilmington it has a drainage area of about 320 square miles, the greater part of which is farm land. The stream is considerably polluted by towns and manufacturing establishments on the watershed. During recent years Wilmington has made an effort to remove these sources of pollution and has been successful to a considerable extent within the State of Delaware. As more than half the watershed is in Pennsylvania, however, the complete removal of the sources of pollution has been made very difficult, if not impossible. The stream is subject to sudden and large variations of flow, and at times of heavy rain becomes quite turbid, thus further complicating the problem of purification. Realizing that the problem is an unusual one, the water department has, during the past four years, examined a number of projects and has called in consultation several specialists in water purification, among whom were Messrs. Allen Hazen and Samuel M. Gray. Since 1905 the Department has employed Dr. A. Robin as bacteriologist, and has maintained an analytical laboratory and several experimental filters.

For some years past the river water has been used without treatment except the slight sedimentation which took place in the storage reservoir. The water is taken from the creek at a dam about 4,800 ft. upstream from the principal pumping station and is conveyed along the southwest bank of the stream to the pumping station in a concrete-lined race. The difference in elevation between the water in the race and the stream at the pumping station ranges between 19 and 25 ft., the variation being due to the fact that the Brandywine at the station is tide-water and has a daily rise and fall of nearly 6 ft. This head of water has been used to operate a breast wheel to which is connected a 3,000,000-gal. pump; and there are also a Wetherell 10,000,000-gal. pumping engine and a Worthington 7,000,000-gal. pump. These pumps deliver water taken from the creek to the low-service reservoir, about 145 ft. above low tide. The water used by the lower portions of the city flows directly from this reservoir. The higher portions of the city are served from a high-service reservoir 244 ft. above low tide, which is filled from the low-service reservoir by pumps of 6,000,000 gal. capacity. Sections of the city too high to receive water from the high-service system are supplied from a water tower 320 ft. above low tide.

Prior to the summer of 1903 the Brandywine water in passing from the race before reaching the pumps passed through a Sellers' filter described in The Engineering Record of Sept. 16, 1893. Provision was made for upward filtration through various sizes of gravel and sand and also for aeration and the passage of the water over scrap iron. A series of tests made before the old filter was abandoned led to the conclusion that it was of no benefit as a water purifier and injured the pumps by permitting fine sand to reach them.

Under the new arrangement the water will still be diverted from the creek through the old race, from which it will pass to preliminary filters and then by gravity to the pumps in a new station which occupies the site of the old Sellers filter, the latter having been entirely destroyed. From the pumping station the water is to be forced through the 43-in. main up to a sedimentation reservoir, 285 ft. above low tide. Though for the present the water will flow directly from the sedimentation reservoir to the low-service reservoir, it will eventually pass through slow sand filters into a filtered water reservoir, 253 ft. above low tide. Thence the supply will be delivered to the low-service reservoir and the mains of the high-service system, the plan being to abandon the pumping plant at the low-service reservoir as soon as the new sedimentation reservoir is put into commission.



General Plan of Reservoirs and Slow-Sand Filters.

The water tower will still be used for extreme high service and will be filled from the high-service mains from the new reservoir, the pumping to the extra elevation being done with power derived from the flow of water from the sedimentation or filtered-water reservoirs. Under normal conditions the flow from this source to the low-service reservoir will amount to about 6,000,000 gal. per day under an average effective head of about 100 ft. This power will serve not only to pump water to the tower but will also be used to generate current for about 140 arc lamps. A turbine will be placed within the gate-house on the distribution main feeding the low-service reservoir and the generator will be direct-connected to the turbine.

The new pumping station and preliminary filter, together with the building of the old plant that still remain, occupy a strip of ground along the Brandywine about 1,000 ft. long and about 200 ft. in maximum width. The new pumping station is at the extreme upstream end of this strip on the site of the old Sellers' filter. Below the new pumping station is the old pump house which is to be torn down when the new pumps are put in operation. Next is the old boiler house which is to be changed somewhat and provided with coal storage facilities. Below the old boiler house the new preliminary filter plant is being built. A great part of this strip of land was formerly so low that it was inundated at every low tide. This land has been redeemed and built up to a general elevation of 15 ft. above low tide by the construction of a masonry retaining wall along the Port Warden's line. The main wall is 15 ft. high, 6 ft. 6 in. wide at the base and is surmounted by a parapet wall 2 ft. 7 in. high. The base was built of concrete in general on rock foundation and the superstructure is heavy rubble masonry. The wall is 837 ft. long, contains 2,108 cu. yd. of masonry and cost $14,008.98, or an average of $6.64 per cu. yd.

The Preliminary Filters.—As has been indicated the preliminary filters are of the type devised by Mr. P. J. A. Maignen. A report of Messrs. Hering and Fuller to the city of Philadelphia in regard to this system was printed in abstract in The Engineering Record of Nov. 22, 1902. The preliminary filters built by Mr. Maignen at the Lower Roxborough Filter Station, Philadelphia, were described on July 30, 1904, and the plant at South Bethlehem on July 15, 1905. The main difference between the Wilmington plant and other installations is that in the new plant the sponge clipping will be cleaned in the filter instead of in laundry machines. The filters are intended to remove about 70 per cent. of bacteria and turbidity. This is accomplished by upward filtration through coke and sponge clippings at the rate of 50,000,000 gal. per acre per day, at which rate the filters will have a total capacity of 15,000,000 gal. In plan the plant has outside dimensions of 115 ft. 9 in. by 192 ft. 4 in., the longer sides being nearly parallel to the creek bank. This area is divided by transverse walls into ten filter beds and a filtered-water reservoir. Each filter bed has inside dimensions of 14 ft. 5 in. x 100 ft. and the reservoir is 105 ft. 9 in. x 30 ft. 4 in. inside. In general the depth of both filters and reservoir is about 8½ ft. The walls and floors are of concrete reinforced with Ransome twisted bars.

Distributing Main Crossing the Van Buren St. Bridge.

The raw water is drawn from the race and led along an influent gallery which extends the entire southerly side of the plant. Opposite the longitudinal center line of each filter bed in the floor of the influent gallery is a weir opening controlled by an adjustable gate and float. Flowing through this regulating weir the water enters an inlet drain extending along the longitudinal center line of the filter bed floor. This inlet is built of reinforced concrete and is 3 ft. wide and about 6 in. deep inside. Both sides are provided at 1 ft. intervals with vertical slits, and the water passing from these orifices rises successively through 6 in. of gravel, 20 in. of coke and 20 in. of sponge clippings. The last are held in place by cypress racks which in turn are held down by wooden frames attached to short pieces of channels imbedded in the concrete division walls. The water leaves each filter bed through a 12x12-in. sluice gate at the north end and flows into an effluent gallery extending along the northerly side of the plant and into the filtered-water reservoir. The flow from the reservoir to the pump is by gravity, the exit from the reservoir being through a 48x60-in. sluice gate.

In cleaning the filters, compressed air is to be used in agitating the filtering material and wash water. Along each side of the plant above the ends of the filter beds is hung a 12-in. spiral-riveted galvanized iron air main and from each main a 9-in. brass pipe runs down to each filter bed and across the end of the floor. From each 9-in. end pipe, two 6-in. brass pipes run along the filter bottom half the length of the bed. From the 6-in. pipes, ½-in. brass pipes branch out at right angles on both sides at 12-in. intervals. These are closed at the free end and are perforated with 1/16-in. holes at intervals of about 3 in. In cleaning the filters the flow of air is necessarily always upward, but the flow of water may be in either direction. If an upward flow is desired the compressed air is turned on and the filter is otherwise operated as usual except that instead of allowing the effluent to flow into the collecting gallery it is turned off through a 12x12-in. sluice gate placed in the corner of the bed at about the same elevation as the gate opening into the gallery. Through this waste gate the wash water flows into a 12-in. cast-iron drain pipe embedded in the filter wall. This pipe connects with a 12-in. main placed in the bottom of the filtered water gallery and leading to an outfall into Brandywine Creek. If a downward flow of wash water is desired the flow through the inlet weir is cut off and a 12-in. sluice gate in the wall of the influent gallery is opened, allowing the raw water to flow into the top of the filters. At the same time a valve is opened on the pipe leading from the end of the inlet drain to the waste water system. The water then flows downward through the filtering material and passes out through the slots and into the waste pipe. Sluice and gate valves made by the Pittsburg Mfg. Co. are used in the filter plant.

Concrete Mixing Plant at the Preliminary Filters.

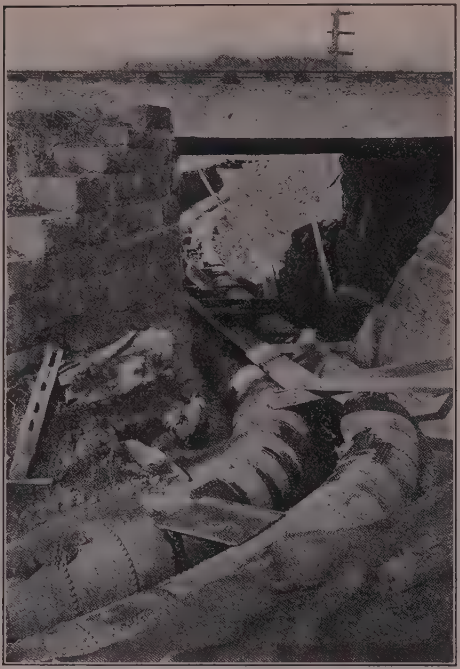
The filtered-water reservoir is covered with 8 in. of reinforced concrete supported on I-beams. Over both the filter beds and reservoir is to be built a filter house, the brick walls of which will rest on the outside concrete walls of the beds and reservoir.

The concrete used in the filter plant is a 1:3:5 mixture of Atlas Portland cement, sand and crushed granite. The materials are brought up the creek on a barge at high tide and are delivered to storage piles on the bank with a stiff-leg derrick operated by a Lidgerwood hoisting engine. A Ransome mixer is placed on an elevated platform on the stream side of the plant opposite its center and from this mixing platform elevated runways lead out over the work. The raw materials are delivered from the storage piles to the mixer with the derrick and the concrete is wheeled to place along the runways in special two-wheeled barrows.

The Pumping Station.—The new pumping station is 64 x 114 ft. The foundation courses are Brandywine granite, and above the water table it is built of light brown colored mottled brick, manufactured by O. W. Ketcham, Philadelphia. The exterior is trimmed with granite and terra-cotta. Above the main floors the interior walls are of porcelain-faced brick with the exception of the wainscoting and baseboard, which are of white and brown enamelled brick respectively. The main floor is of reinforced concrete supported on I-beams. Space is available for three pumping engines, but at present only two are being installed, one at each end of the building. These are 12,000,000-gal. vertical, triple expansion machines, built by the Holly Mfg. Co., at a contract price of $79,769 each. Steam is to be supplied by four 300-h.-p. horizontal water-tube boilers built by the Edge Moor Iron Works. Two of these boilers are now in use at the old boiler house and two more are being built at a contract price of $9,880 per pair. The entire main floor of the pumping station is commanded by a 15-ton crane having a span of 60 ft., built by Maris Bros., Philadelphia.

It is intended to utilize the fall from the crest of the dam to low tide at the pumping station in operating wheel-driven pumps. It is calculated that with an effective head of 19 to 23 ft. and pumping against 285 ft., the quantity pumped by water power will be 7,890,000 to 9,000,000 gal. For this purpose three 60-in. turbines, two mounted in tandem and one singly, and direct connected to the pumps, will probably be used operated at the rate of 96 r. p. m.

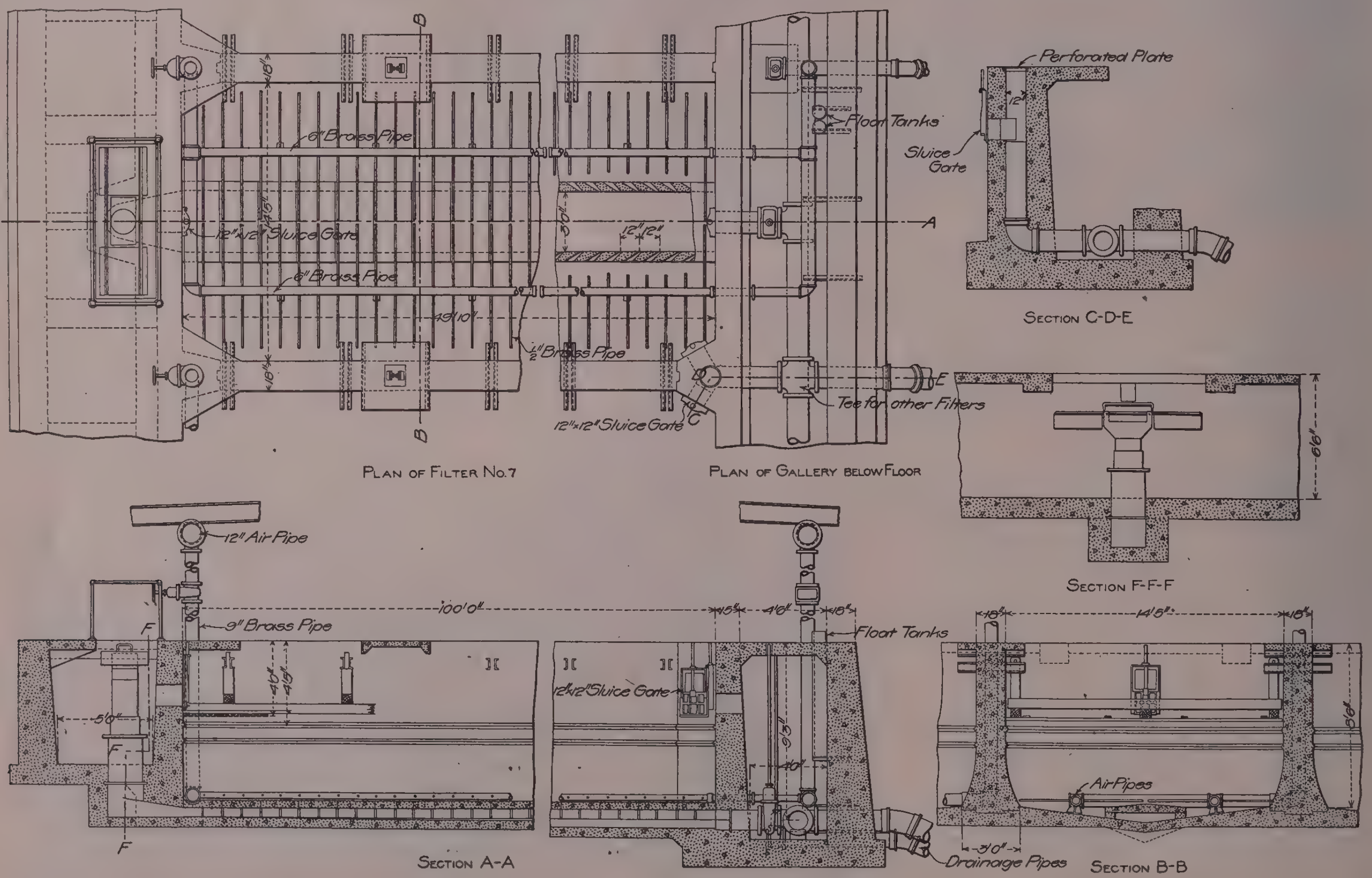
The Force and Distribution Mains.—The 43-in. and 48-in. pipes leading to and from the sedimentation reservoir are made in 30-ft. lengths with lock-bar longitudinal and riveted butt strap transverse joints, the metal being 7/16 in. or ⅜ in. thick, depending on the pressure. The pipe is shipped from the shops of the East Jersey Pipe Co., Paterson, N. J., on flat cars and is hauled in Wilmington on trucks built up to the level of the car floor. The manner of laying these pipes was described in The Engineering Record of March 3, 1906.



Force and Distribution Mains.

The Sedimentation Reservoir.—The 35,000,000-gal. sedimentation reservoir which is now about three-quarters finished is located about 1½ miles from the new pumping station, near the site of the slow-sand filters. It is triangular and placed so as to leave room for another similar reservoir. The full depth of water will vary from 17 to 21 ft., the latter at the sump, 264 ft. above low tide. The embankment, which is formed of clay excavated on the site, has a maximum outside slope of 2 to 1, and a uniform inside slope of 1½ to 1, and is 15 ft. wide on top where an 8-ft. macadam driveway is to be constructed. The embankment was built up in 6-in. layers, each thoroughly compacted by wetting and rolling with a 10-ton steam roller with cleated wheels. The outer slopes are to be sodded and the inner slope and the bottom of the basin are lined with concrete placed over 12 in. of puddle. This puddle is a mixture of equal parts of clay dredged from the Delaware River, and screened crushed trap rock, which passes a ¾-in. ring. The mixing is done in a pug-mill and the puddle while in a plastic state is placed in 6-in. layers, each layer being thoroughly compacted before another is applied.

Over the puddle is a 6-in. layer of 1:2½:5 concrete composed of Vulcanite Portland cement, sand and crushed Brandywine granite, 1½ in. in size. This concrete is laid in 30x10-ft. blocks, the joints being calked with oakum and asphaltum. The blocks first laid on the reservoir floor were placed so that the 10-ft. joint lines were regularly broken, the offset being half the length of a block or 15 ft. This resulted in the cracking of some of the blocks across their transverse center lines, an effect which is thought to be due to the contracting effect of low temperature combined with friction along the longitudinal joint lines between the blocks. Under these conditions the weaker blocks would, of course, be the ones which failed. The remainder of the floor blocks are therefore being laid with the short joints in an unbroken line. About halfway up the inner slope of the embankment, the layer of concrete is offset so that the upper half of the slope may be paved with 6-in. granite blocks and an even face slope still be maintained. Belgian blocks are used, bedded on screenings and asphalt with their joints filled with cement grout, except those of the lowest course, where hot asphalt is used. The concrete for the lining is prepared in a Smith mixer and hauled to place in two-wheel carts.



Plan and Sections of a Preliminary Filter, Wilmington.

The 43-in. force main enters the reservoir at one corner and extends to within about 100 ft. of the opposite side. The end of the pipe is closed and four tees are provided as inlet openings, two being horizontally placed on each side of the main pipe. The sump toward which the floor slopes from all directions is near the same corner and is connected with an 18-in. cast-iron pipe to a 24-in. terra cotta pipe drain outside. In the same corner is the weir tower to which the 48-in. distribution main runs. This is a rock-faced masonry and concrete structure circular in cross section and rising about 25 ft. above the maximum high-water level. Three 36x60-in. sluice gates are provided through which the water can be taken from various elevations. These are operated by hand wheels placed in a gate chamber reached by a foot-bridge from the reservoir bank. Above this chamber in the top of the tower is a small water tank which will be used in connection with a domestic water supply system for the gate house and laboratory.

The gate house is a two-story and basement brick building 37 ft. 10 in. x 30 ft. 10 in. in plan. The basement is occupied by the valves on the force and distribution mains. These are so arranged that the reservoir or filters or both can be cut out and the flow turned directly from the force main into the distribution pipe if necessary. Provision is also made for the connection of inlet and outlet pipes to a second reservoir. The valves used about the gate house and reservoir were manufactured by the Eddy Valve Co. The second floor of the gate house is devoted to bacteriological and chemical laboratories and offices for the engineer and bacteriologist.

Slow-Sand Filter and Pure Water Reservoir.—It is intended to construct at present eight covered slow-sand filter beds, leaving room for future extensions as shown on the general plan. The beds will be symmetrically arranged along a courtway and also on both sides of the 43 and 48-in. pipe lines. Each bed is to be 108 x 201 ft. in plan, and the eight beds will thus have a total area of about 4 acres. The rate of filtration which it is expected to use is three to four million gallons per acre per day. A feature of the plant will be that the washed sand will be stored in bins built along the sides of the main court and contiguous to the ends of the filter bed. It will thus be protected from dirt and kept from being thrown about and wasted.

The filtered water reservoir will be 261.5 ft. square inside, and about 20 ft. deep, its capacity being about 10,000,000 gal. The structure is to be built of concrete, the roof being of groined arches supported on 2x2-ft. concrete columns spaced 15½ ft. on centers.

The Van Buren St. Bridge.—The reinforced concrete Van Buren St. bridge is being built jointly by the Water Department and Park Commissioners, the former paying two-thirds and the latter one-third of the expense. While constructed primarily to carry the 48-in. distributing main over Brandywine Creek, the bridge will also be a connecting driveway between North and South Brandywine Parks. It consists of three main arches, each of 56 ft. span, and five approach arches, one of which has a span of 33 ft., another 9 ft., and three 28 ft. each. The total length of the structure is 358 ft. and its width is 27 ft. The concrete is a 1:2:4 mixture of Lehigh Portland cement, sand and crushed Brandywine granite. The arches were designed on the Melan system, built-up steel ribs being used as reinforcement. Where steel rods are necessary for reinforcement, Thacher bars are used.

When the bridge was begun it was intended to deliver the concrete by means of a trestle track built across the creek parallel to the bridge. When this trestle was partly constructed, a flood of water washed it away and it was never rebuilt. Instead two guyed derricks were placed in the stream, as shown in an accompanying illustration, and the concrete was handled by them from the mixer on the bank. When the bridge is completed the distribution main will be entirely imbedded in concrete, its top being about 12 in. below the surface of the bridge floor.

All of the designs for the new structures, both architectural and engineering, in connection with the improvements of the water supply system of Wilmington, have been prepared by Mr. Theodore A. Leisen, M. Am. Soc. C. E., chief engineer of the Water Department, under whose general supervision the construction work is being carried forward. Mr. Leisen has had as assistants on this work Mr. John A. Kienle, present assistant engineer, and Mr. Edward R. Mack, former assistant engineer, and now engineer in charge of the Park Department.

The new pumping station was built by the A. S. Reed & Bro. Co., of Wilmington, at a contract price of $56,900. The preliminary filters are being built by the Pittsburg Filter Mfg. Co., at a contract price of $63,546. The sedimentation reservoir and gate-house are being built by Mr. J. T. Finch, Glens Falls, N. Y., for a contract price of $161,115. The Concrete-Steel Engineering Co., of New York, was the consulting engineer on the Van Buren St. bridge, which is being built by the John A. Kelley Co., of Wilmington, under the supervision of Mr. A. L. Carhart, at a contract price of $36,000.

A GANZ STEAM MOTOR CAR has been ordered by the Chicago, Rock Island & Pacific Ry from the Railway Auto Car Co., New York. The car is to be 54 ft. 10¾ in. long and is to have a seating capacity of 52. It will be designed for a speed of 35 miles per hour.

Portable Railways on Contract Work.

While the standard gauge railways in this country are superior in nearly every respect to those in other parts of the world, the narrow gauge and especially the portable railway is not used to a great extent in America. Mr. Arthur Reiche, general manager of the Arthur Koppel Co., has made many investigations to ascertain why such railways are not more used here, and has become convinced that the only reason is that the contractors in America are not familiar with the advantages of this system of conveying, for portable railways can be used here to even better advantage than in Europe because wages and the cost of maintenance of draught animals are generally two or three times higher and there is a greater scarcity of laborers.

It is true that in the United States, narrow-gauge railways equipped with locomotives and heavy box dump cars running on rails of 30 to 75 lb. are used, but only to transport very heavy quantities of material, while on the other hand the transportation of smaller quantities is done practically everywhere by means of scrapers, wheelbarrows and dump carts. The country in which narrow-gauge and portable railways are used to the greatest extent is Germany, and everyone who has traveled much there will have observed, even in the large cities, the portable track with dump cars of different types used to advantage for dirt and materials, for sewerage work, paving, railway and bridge construction, the excavations for large buildings and concrete work of all description. Mr. Reiche is convinced that this system of transportation can be used to the same advantage in this country, and has furnished some practical data in support of this decision.

Messrs. Dodge & Day, consulting engineers, Philadelphia, who devote their attention to the betterment of industrial plants, have given him comparative data for the construction of a siding, part of which has been built with wheel scrapers and the other part with portable track and cars. The work done was grading on a spur being built for the Pennsylvania R. R. Company near Homewood, Pa. About 25,000 cu. yd. of earth was moved, approximately two-thirds of it being moved with the portable railway and the balance with wheel and drag scrapers.

The wheel-scraper work was nearly all borrow-pit work, and the soil was good average earth, easily plowed with a three-horse grading plow. The haul was from 150 to 450 ft., averaging 350 ft. The labor prices on the scraper work were as follows for 10-hour day, No. 3 Western wheel scrapers being used; the number being varied to suit the haul: Two-horse team at $5, three-horse snap team at $7.50, three-horse plow team at $7.50, foreman at $3, two scraper loaders at $1.75, one dump man at $1.75.

The car work was in a wide cut and borrow pit averaging 5 ft. in depth; about one-third of the material was a hard gravel clay which could be plowed only with a three-horse rooter plow. All material was plowed. The average haul was about 650 ft. Koppel's 24-in. gauge portable track with rolled steel ties was used. Temporary spur tracks were laid over the cut and plowing was done on both sides of them. The Koppel standard double side dump cars were used in two trains of four cars, each of 1 cu. yd. capacity. This load was easily pulled by one horse.

The dump-car track was on a light trestle constructed of round timber, cut in the vicinity and averaging 20 ft. in height.

The labor prices on the car work for a 10-hr. day are given below. Owing to the scarcity of labor, great trouble was had in keeping the proper size gangs to work the car outfit at the best efficiency: Foreman at $3, laborers at $1.65 (their number varying, but averaging four shovelers per car), plow team at $7.50, one-horse team at $3.50, three dump men at $1.65, and track man at $2. In the daily cost is included the cost of carpenters building trestle.

The daily records showed that the cost of the work with wheel scrapers was 26¼ cents per cubic yard for an average haul of 350 ft., against 24¼ cents with portable track and an average haul of 600 ft.

The cost of repair work on ten cars during nearly five months did not amount to over $1, and they were practically as good as new.

Other comparative data showing the difference between the cost of concrete work done with wheelbarrows and Koppel's portable track have been recently given by Mr. Wm. S. Fargo, consulting engineer, Jackson, Mich. At the present cost of labor and frequent difficulty experienced in securing efficient laborers, the wheelbarrows should seldom be used for large concrete work, in his opinion. A tip car with roller bearings running in oil in tight cases will enable a man to push on level track from five to eight times a wheelbarrow load of concrete.

The car-plant costs given by Mr. Fargo are as follows: Double-track trestle, 24-in. gauge, 6 ft. between centers of tracks, 6x8-in. stringers, 22 or 24 ft. in length, 2x6-in. ties on 2½-ft. centers, 2x12-in. running boards between rails, 12-lb. rails, trestle legs averaging 30 ft. in length of green poles at 5 cents per foot, will cost complete $1.50 per lineal foot of double track, or for 150 ft. at $1.50 erected, $225; five split switches at $18, $90; two iron tables at $30, $60; three ⅔-cu. yd. steel cars with roller bearings, $190; total, $565.

This outfit, with repairs and renewals amounting to 10 per cent., should be good for five seasons' work and the timber work for several jobs, if not too far apart. The yearly rental on the basis of five seasons' work would be $124, or $1 per working day for a season of five months. Three cars delivering one-half yard batches can deliver 200 cu. yd. of concrete, an average of 100 ft. from the mixer in 10 hours. Five men, including a man tending switches and turntable and one man to help to dump, can operate the plant on the basis of $1.75 per day. The labor cost of hauling 200 cu. yd. of concrete would be 4⅜ cents per yard; therefore, this would be a saving of about 5¾ cents per cu. yd. over the cost of the delivery by wheelbarrows.

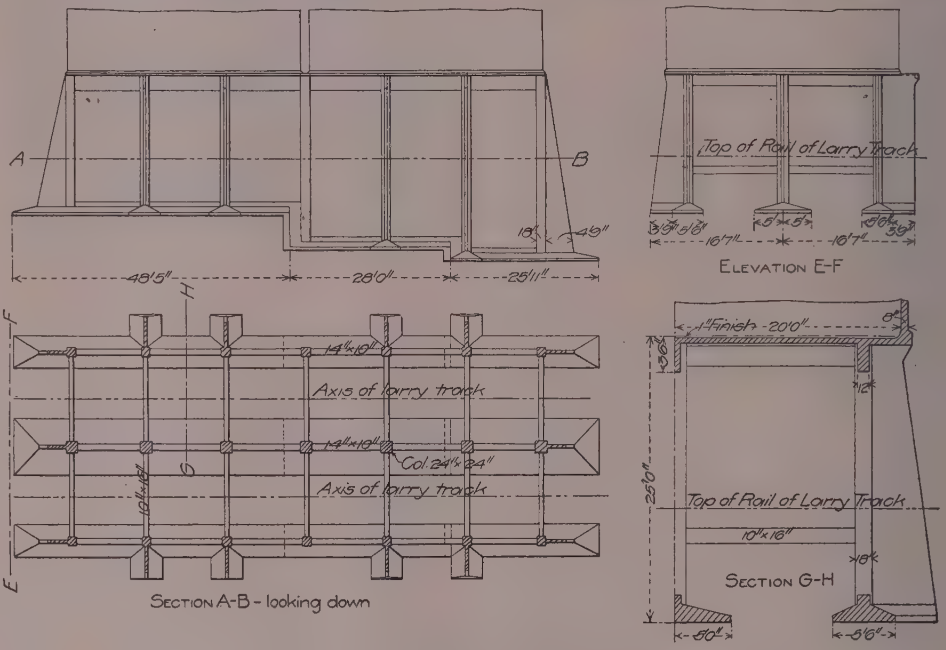
A RIVER POLLUTION DECISION recently rendered by the Iowa Supreme Court in Vogt v. City of Grinnell, 110 N. W. Rep. 603, is unusually explicit regarding the judicial views on the subject in that State. Where a nuisance results from the construction by a city of works expressly or by necessary implication authorized by statute, the city is not liable in damages unless the nuisance is occasioned by some neglect on its part in construction or maintenance. In this case the statute authorized the city to construct a sewerage system but it nowhere authorized it to discharge its sewage into a running stream. On the other hand, there is a statute which makes the fouling of such a stream a public offense. Admitting that the sewerage system was mechanically perfect and operated to the satisfaction of those whom it was intended to serve, the court ruled that the unauthorized discharge of the sewage into a stream to the material injury of a lower riparian owner was a wrongful act, and no degree of care in the manner of doing it could purge the act of its wrongful character if its necessary effect was to pollute the stream to the injury of others. The plaintiff was accordingly awarded damages. The decision is of importance because the case has been vigorously fought, having once before been before the Supreme Court.

The Coal Pockets of the Salem Mines.

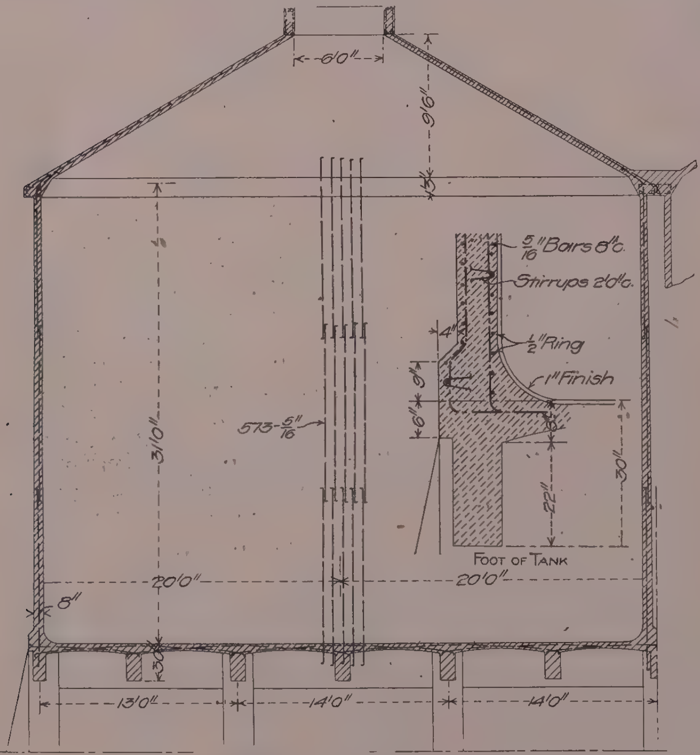
Two large coal pockets have recently been built of reinforced concrete for the Salem mines of the Easton Coal & Coke Co., at Alexandria near Greensburg, Pa. They form part of a single structure of rather unusual character and consist essentially of two vertical cylinders 40 ft. in diameter and 31 ft. high to the base of the concrete roof. They are seated close together on a concrete platform, with which their bases are integral at an elevation of about 25 ft. above the lowest point of the foundation or 20 ft. above the surface of the ground. The 42x102-ft. platform is approximately rectangular. It is essentially a large flat table supported on 21 rectangular concrete columns 13 and 14 ft. apart in three longitudinal rows about 16½ ft. apart. The columns are arranged in seven transverse bents, carrying longitudinal and transverse girders at their upper ends and braced by a single line of horizontal transverse girders carrying two lines of service tracks near the foot of each bent. The column bases are seated on wide footings extending continuously from end to end of the structure and distributing the heavy load over a sufficient area of the soft ground to obtain a unit pressure of 1,500 lb. per square foot. As the ground slopes considerably, it was decided to provide offsets of a total height of 8 ft. for the three different sections into which the footing was divided.

All columns are braced both transversely and longitudinally top and bottom. The upper bracing consists of the beams, girders and floor slabs of the coal bins; the lower bracing is effected by the continuous longitudinal footings and by the transverse beams, supplemented by full-length vertical solid-web kneebraces on the outside faces of all exterior columns. These kneebraces are uniformly 6 in. in thickness and increase to a width of about 5 ft. at the bottom where they are integral with extensions of the footing. All of the construction below the floorbeams and girders is made of 1 to 3 to 5 Alpha Portland cement concrete without reinforcement. The center columns, 24 in. square, are proportioned for loads of 400,000 lb. The outside columns 14 in. square carry loads of 280,000 lb. The footings have a minimum thickness of 6 in. at their edges and the upper surface is beveled to a maximum thickness of 18 in. at the center, where it is increased 10 in. more by a continuous vertical web making of it a T-shaped girder.

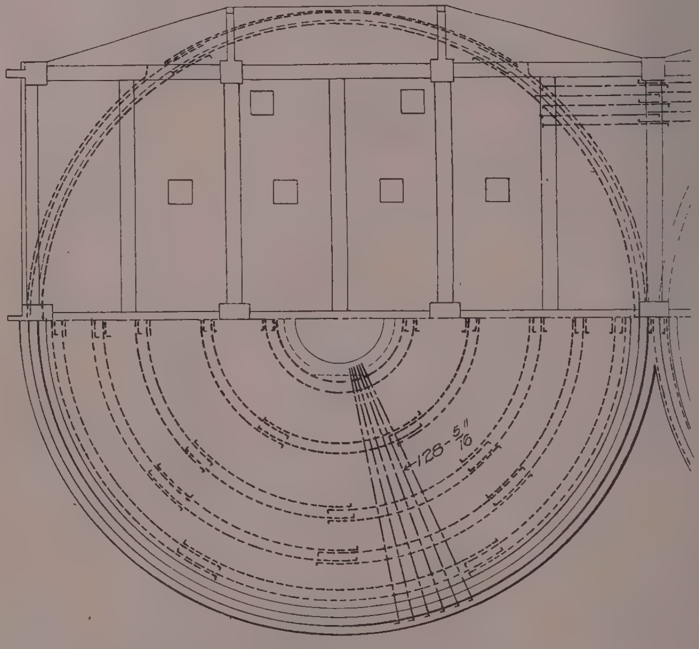
The Salem Mines Coal Pockets.



Plan and Elevations of Substructure.



Vertical Center Section.



Half Plans, Roof and Floor.

The floor slab is made of a series of very flat arches supported on transverse beams 6 ft. apart. It has a minimum thickness of 5 in. increased to 8 in. at the beams and is reinforced by 5/16-in. longitudinal and transverse bars 8 in. apart. The floorbeams are 12 in. thick and 36 in. deep, inclusive of the thickness of the floor slabs, and are reinforced by one 1-in. rod in the upper part and by four 1⅝-in. rods in the bottom part, two of which are straight and two bent. The 12x36-in. floor girders are reinforced by four 1⅜-in. top rods and four straight 1¾-in. and four bent 1⅝-in. bottom rods. The floor is proportioned for a maximum load of 1,600 lb. per square foot and has 12 holes 15 in. square through the bottom of each bin for cast-iron gates.

The bins have a capacity of 800 tons of wet coal each and their cylindrical sides are integral with the floor concrete, to which they are filleted. The thickness of the sides tapers from 5 in. at the top to 8 in. at the base. They are reinforced by straight vertical and horizontal rods. The former are 5/16-in. in diameter and 8 in. apart and are made in three lengths. The latter are made of ½-in. rods for a height of 22½ ft. above the bottom of the bins and are 2 to 4 in. apart vertically. In the upper part of the bins the rods are ⅜ in. in diameter and 3 to 12 in. apart. The roof is a conical slab without ribs, rests directly on its lower edge, and is reinforced with radial and horizontal rods. The horizontal rods are 3/8 in. in diameter and 10 in. apart; the radial rods are 5/16 in. in diameter and 12 in. apart at the base. At the apex of the roof there is a circular curved girder 6 ft. in diameter, about 23 in. deep and 8 in. thick, reinforced with eight ½-in. circular rods.

The roof was proportioned to carry its own weight and the conveyor apparatus. The walls and floors were covered with a double coat of cement finish. The concrete was mixed by hand, elevated to the required height by an ordinary hoisting apparatus and was distributed around the structure by wheelbarrows on plank runways.

The walls were cast in forms made of inside and outside segmental shutters about 5½ ft. wide and 7½ ft. high. Adjacent shutters were connected to each other with radial butt joints and were spaced by wooden separator blocks built into the concrete and afterwards removed, leaving 4x4-in. holes which were very convenient to receive supports for the inside centering and were filled with mortar after the centering was removed. Each shutter was made of vertical 6x1-in. square-edge boards nailed to four horizontal transverse 2x8-in. scarf boards which were X-braced on the outside by 6x1-in. planks. The lower edges of the vertical boards projected 1 in. below the bottom scarf boards to engage corresponding recesses in the top scarf boards of the preceding course and thus made a joint between the successive courses. Each course required 24 inside and 24 outside panels, and 96 of each were built at the shops, thus providing for three courses, reaching together the full height of the walls. Concrete was delivered to an inside scaffold and from it was rammed into the form, where it was kept at a uniform height on all parts of the circumference. Continuous work was maintained until it was completed, usually requiring about 20 men for about 8 successive hours. The inner surface of the walls was finished with 1 in. of hard cement mortar. The roof concrete was applied by a trowel on the conical centering and required no outside form boards.

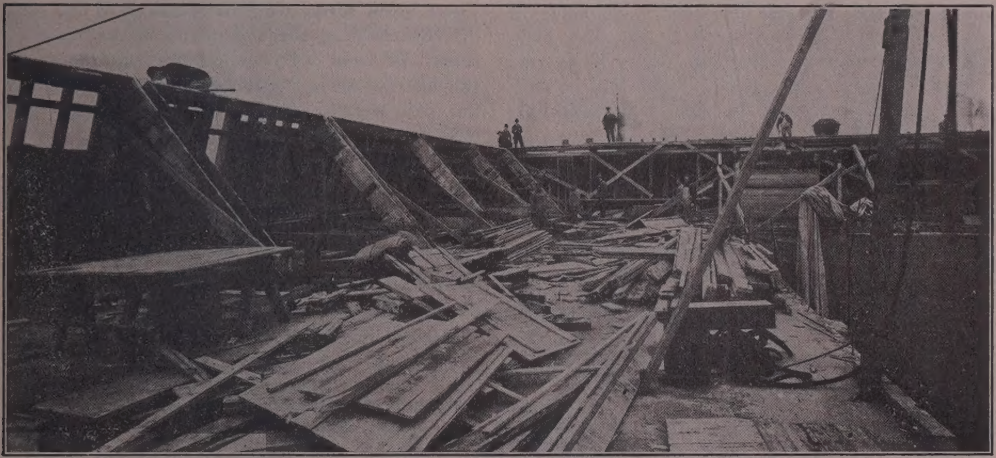
The bins are parts of a coal washing plant designed by the Roberts & Schaefer Co., of Chicago. The details were worked out and the structure erected by the Baltimore Ferro-Concrete Co., Mr. Herbert J. West, president, and Mr. Henri Kampmann treasurer.

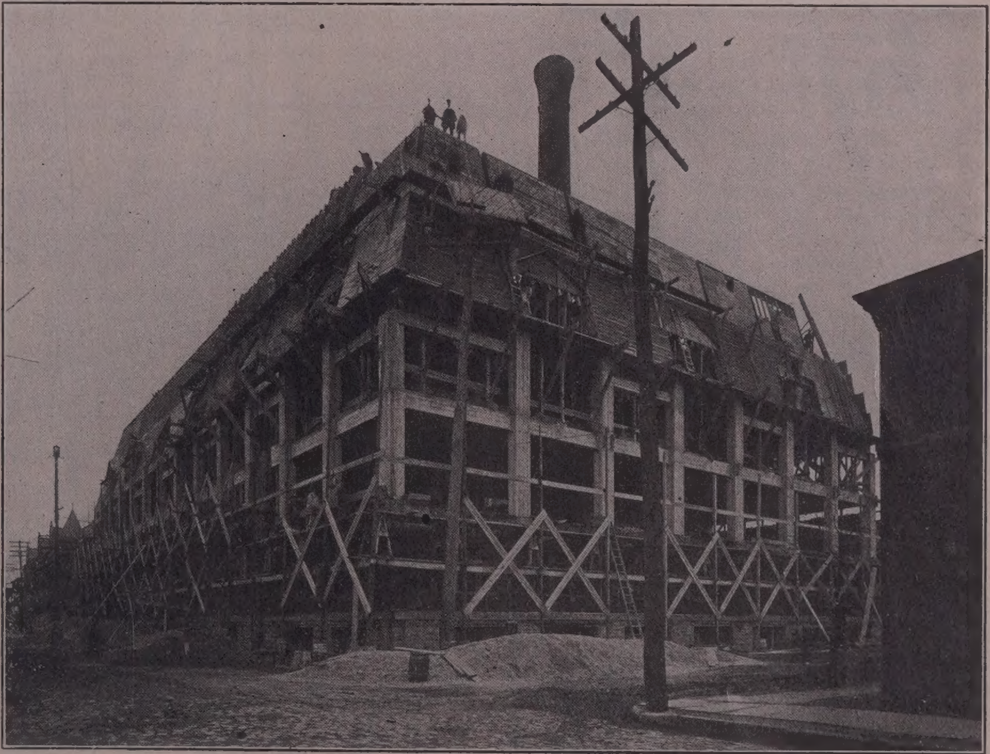
Designers of Railway Bridges will be interested in the class H-8 type of consolidation freight locomotives recently designed by the Pennsylvania R. R., for service between Altoona and Philadelphia. The eight driving wheels of this type are 62 in. in diameter. Three of the driving axles carry a load of 51,000 lb., the main driving axle 54,000 lb. and the truck axle 31,000 lb., making a total locomotive load of 238,000 lb. The tender in working order weighs 143,000 lb.

The New Factory Building of the Murphy Varnish Co.

By Wm. F. Burleigh, Assistant Superintendent, Murphy Varnish Co.

The Murphy Varnish Co. is erecting at its plant at Newark, N. J., a reinforced concrete building that is of interest in its style of architecture, not usually seen in factory construction. It will be used for color manufacturing and will contain considerable heavy machinery, such as color grinding and mixing mills. It was required that this building should harmonize with the other buildings of the company in adjacent streets. This precluded the use of concrete surfaces in the facade, the other buildings being of brick with sandstone or blue stone trim, and sloping slate-colored roofs.

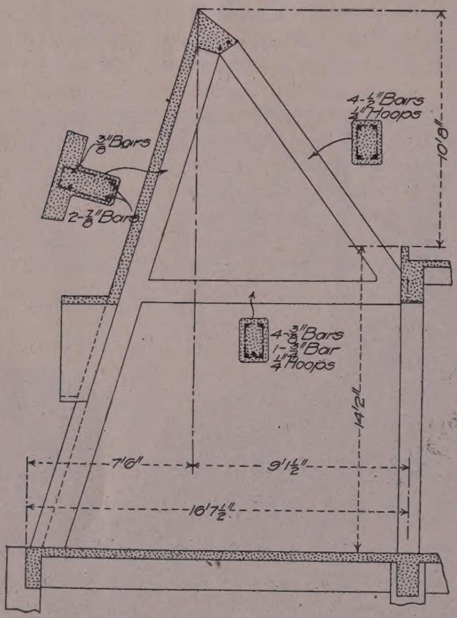

Forms for Mansard Roof.


Murphy Varnish Company's Building, under Construction.

The building is of skeleton concrete construction, reinforced with Ransome bars. All windows are of standard fireproof design, having metal frames and wire glass. In the rear the windows occupy the entire wall surface between columns, except the curtain wall below the sill. In the front they are set in the brick curtain walls, leaving a 5-ft. pier about the columns. The building occupies the entire block of 200 ft. and extends 80 ft. and 110 ft. respectively on the side streets. The wall columns are spaced 14 ft. 11 in. uniformly, except at corners, and the building depth of 40 ft. from streets requires a line of interior columns spaced 19 ft. on centres with the wall columns. There are five floors, including the basement, of approximately 12,000 sq. ft. each. The building is divided into three sections by the 6-in. fire partitions of the two stair and elevator wells. The plan of the building is such that should the future require, it can be extended entirely around the plot, 200 ft. square. This plan provides an inner court having covered shipping platforms, from which entrance is had to each elevator and the first floor. The inner court is entered by a covered drive through the building.

The floor to floor dimensions are 9 ft. 4 in. for basement, and 12 ft. 6 in. for the four stories above. The street front is of heavy rock-faced bluestone to the top of a water table about 4 ft. 10 in. above curb. Above this it is brick with terracotta trim and sills to a heavy cornice of terracotta just below the fourth floor. A high mansard roof is covered with slate and broken by dormer windows in alternate bays. These dormers, being surmounted by massive terracotta pediments, produce a pleasing architectural effect, and from a narrow street suggests a building of less height than four stories. The ridge is 11 ft. 6 in. above the flat roof, thereby obscuring the sight of the water tank and pent houses from the ground. The floors are designed for a uniform load of 300 lb., except a portion of the third floor which is provided for a load of 400 lb. due to varnish storage tanks. The inclined slab of the steep mansard roof is designed for wind pressure only, outside of its weight, and that of slate and skylights. Extra reinforcement in four adjacent columns provides for a 20,000-gal. water tank over the roof.

The soil under this property is a good grade of building sand, having a slight amount of clay, and that excavated has been used in the concrete. Owing to the somewhat slower setting properties of concrete made from this sand during the fall and winter months, it has been mixed, where desirable, with equal parts of the coarser and cleaner Cow Bay sand. This has allowed the earlier stripping of forms on mullions and unloaded portions. As the floor top finish is put on at the same time with the slab, this mixture has assisted the setting of the cement and grit top finish over it, and lessened the time of the finishers. Tests on cubes of 1:3 mortar made with this sand previous to starting of the work showed practically no difference in strength from those with Cow Bay sand. At the western front there was found at about the footing level a bed of peat underlaid with clay, the remains of an old marsh. After wash borings were made it was decided to drive piles here, cutting them off 3 ft. below the cellar floor level, which is 2 ft. below ground water level.

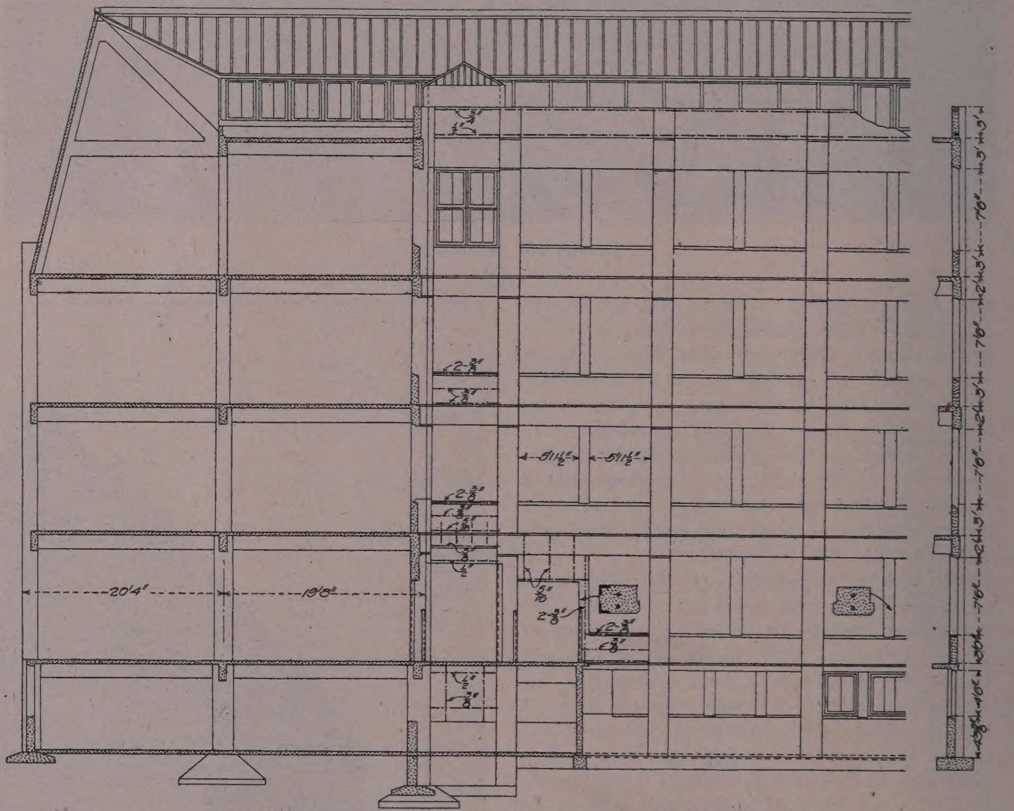


Detail of Mansard Roof.

The front and rear wall footings are of an inverted T section. The flange portion bearing on the soil was first placed with vertical bond bars or dowels of ¾-in. square twisted rods inserted in pairs every 1 ft. 4 in., alternating with mortised sockets in the concrete. In this manner this flange was integrally connected with the web portion set up and poured later. Longitudinal shear was thus resisted, the web and flange being reinforced to act as a continuous inverted girder under the superimposed columns, the lower part of which was poured along with this girder. The interior columns have spread footings generally 9 ft. square designed to allow not over 3 tons per square foot on this soil. These columns are of square section, being reduced in area at the floor levels. They are reinforced with ¼-in. helically wound wire rod to provide for a direct compressive stress of 800 lb. per square inch on the concrete side of helix. This concrete was a 1:2:3 mixture. The columns have in addition plain round longitudinal bars made continuous with screwed couplings. The wall columns are of uniform width, reducing in thickness at succeeding floors. These columns are reinforced with longitudinal Ransome rods and transversely with hoops of ¼-in. rod to provide in this case for a direct compressive stress of 600 lb. per square inch on concrete of 1:2:4 mixture. Girders as well as beams are of nearly uniform section throughout. The floor slab is 4¼ in. thick and finished with a 1-in. granolithic surface. Beams and slabs are calculated for an extreme fiber stress of 500 pounds per square inch.

Cast-iron spools 3 in. high and 2 in. in diameter, tapped for ⅝-in. bolts, are set in all ceilings to receive shafting, or pipe hangers. About 3,100 of these are provided in the whole building. They are spaced symmetrically, eight in each ceiling panel. This allows stringers being bolted in either direction and shafting hangers bolted to these without attempt to plan the shafting beforehand. All floors are pitched 1 in. toward the center, where 2-in. standard pipe couplings with special cast-iron screwed plugs, flush with the floor, are imbedded in the slab. This allows temporary connections being made to drain off the lye solution and water used in the frequent cleaning of the floors. One-inch tin tubes with wooded cores were placed transversely in the centre of the beam and girder forms, just below the ceiling. These provide openings for passing wires and conduit for lighting circuits, the wooden cores being driven out when the forms are removed and used over. The concrete was left out of small sections of the floor slab, the reinforcing rods remaining, where it was intended to run vertical pipes. These will be subsequently filled around the pipes and made uniform with the floor surface.

One complete set of column and floor forms were constructed and these served throughout. The concrete was mixed in a one-half yard Ransome mixer, set up in the basement, just inside of the rear wall which was temporarily omitted at the center bay. This was coupled with a Ransome standard hoist, outside of wall, with hoppers, and gates at each floor. Concrete was distributed on the floors in 6-ft. two-wheel carts after the reinforcement was wired in place and suitably raised from contact with the forms. Joints at the completion of a day's work were always made at the point of maximum moment in the center of beams and slabs. All material was delivered on the street and run direct to the mixer through the front basement windows in 3-ft. barrows.



Partial Section, Murphy Varnish Company's Building.

The mansard roof in reinforced concrete has offered conditions not usually met in factory construction. The slab, inclined at an angle of 16 deg. 45 min. from the vertical, is 6 in. thick. It has no horizontal beams except the ridge, of trapezoidal section. Vertical rafters span from each column to the ridge. The reaction of their upper ends is carried by a diagonal strut to the top of the center columns and so into the flat portion of the roof. This level roof of the rear half acts as a continuous girder in a horizontal plane, having its end reactions in the partition walls and end walls of the building. Owing to the possible removal of the end walls or partitions in any future extension of the building, horizontal beams rigidly connected to the rafters and the top of the center columns were inserted to provide for any transverse stress liable to be thrown onto the columns. These beams also serve as convenient mounting for shafting.

In the construction of this sloping roof, the rafter forms were made up full length and braced by vertical struts and cross-bracing to the proper angle. The forms of the ridge were then framed in, connecting the tops, and suitably supported. These beam forms were independent of the slab, thereby enabling the slab forms to be removed easily and used over. Forms for half the entire sloping roof were constructed. Inside forms for the slab were made for the full height, while only half a set was provided for the outside. These were stripped inside of 48 hours from the time of filling and placed for the upper half. The steel reinforcement was wired in place against the inside forms and 6 in. concrete spreaders were set. The outside forms were then bolted in place against these spreaders. One by two-inch nailing strips for slate were lightly fastened to the outer forms, 8½ in. on centers horizontally, remaining in the concrete face upon removal of the panels. The stoppers for the several days' fill were of 2x5-in. plank notched over the steel, and 1-in. fillers between the nailing strips. This vertical joint was midway between the rafters. In the lower half of the section was filled the first day, the peaks of the dormer openings made convenient stopping places. Here the stopper was easily removed, while in the upper half of it was necessary to leave a temporary slot in the outer forms to allow access to this stopper for removal. This, of course, was closed before filling the next section. As much of the concreting here was done in freezing weather, the under side was enclosed by canvas and provided with fires inside.

The owners' representatives are Mr. Clarence H. Bissell, general superintendent, and the writer, assistant superintendent of the Murphy Varnish

Co., who furnished the general plans and layout and have had charge of the work throughout. The architectural features of the building were designed by Mr. Howard Chapman, 11 Broadway, New York. The reinforced concrete was designed by the Turner Construction Co., of the same address, who, as general contractors for the building, have ably and expeditiously handled this work under the supervision of Mr. Arthur C. Tozzer, C. E., as superintendent of construction.

An Australian Stone Grab.

The engineers in charge of the dredging operations conducted by the colony of New South Wales have recently improved the grab dredges employed in lifting blasted rock. The power ratio of the winding chain drum to the closing chain was made at least 3 to 1, thus improving the grip of the bucket and preventing its tendency to rise off the work, which was shown by some of the forms previously employed. Furthermore, the yokes or brindles were abandoned and a special set of toggle connection adopted, as shown in the accompanying illustration, for the purpose of avoiding capsizes on an uneven or sloping bottom, which happened with the buckets formerly used. The new buckets are stated never to slip off a load up to one ton, and because of the low center of gravity which they possess they rarely turn turtle.

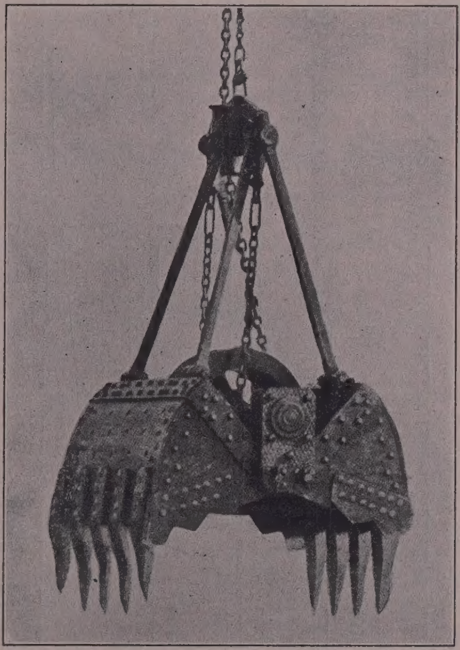
An Electrified Steam Railroad.

An electrified steam railroad with a number of unusual features is in operation in Southern Indiana. It was built originally as a steam dummy line for freight and passengers and has been called the Evansville, Suburban & Newburgh Ry. from its early days, although its most important branch has lately been from Evansville to Boonville, the county seat of Warwick County. The road was originally constructed with 40-lb. rails, but when permission was obtained to use electric traction the roadbed was greatly improved. About 2,200 cu. yd. of limestone ballast to the mile is used, the ties are white oak and laid 17 to the 33-ft. rail, and 70-lb. rails are employed. All told there are 28 miles of main line track, and an affiliated company is building 24 miles more, between Newburgh and Rockport. There are 500-ft. sidings at intervals of about 4 miles. Current is purchased from the Evansville Gas & Electric Light Co. There are three combination baggage and passenger cars, two passenger cars and an express car for electric traction, while for extraordinary demands there are twelve passenger cars and three steam locomotives of the enclosed type. The company is one of the very few electric lines belonging to the American Railway Association and to local associations of steam roads, which gives it the right to receive carload lots from other companies and to bill cars from its own systems to foreign points. It has track connections with the Southern and Illinois Central roads and has 32 standard gondola and box cars for its freight business. The increase in coal mining along its line to Boonville has been so marked that a standard locomotive and more gondolas will be bought to handle the additional traffic. Cars are run every sixty minutes between Evansville and Boonville and every eighty minutes between Evansville and Newburgh. The fare is 2 cents a mile, reduced by commutation rates to 1½ cents. Two steam freight trains are run each way daily between Evansville and Newburgh. Since electricity was adopted as motive power for passenger service, enabling single cars to run at closer intervals than the schedule of steam trains, the amount of travel has increased nearly 40 per cent.

Book Notes.

A valuable compilation of decisions of courts of final jurisdiction regarding the right of cities to purchase patented articles has been prepared by the Warren Bros. Co., of Boston. It is a pamphlet of 80 pages containing information regarding decisions made in Indiana, Iowa, Kansas, Kentucky, Maryland, Missouri, New Jersey and Ohio, and a summary of adverse opinions.

About seven years ago the department of mechanical engineering of the University of Illinois prepared an extension of the standard decimal or Dewey system of indexing to mechanical engineering subjects, for university uses. It was printed in a six-page pamphlet for which there was a large demand. Since that time the index has been enlarged and extended a number of times, and modified to agree with the railroad classification adopted by the International Railway Congress. A new edition has just appeared which contains fairly complete classifications for mechanical and railway engineering, a good one for electrical engineering and some rather detailed classifications for other engineering branches. It forms a pamphlet of 72 pages and is issued as one of the bulletins of the Engineering Experiment Station of the University of Illinois. It is probably one of the most detailed attempts to classify engineering subjects by the decimal system, and will be found a helpful outline of such work by those who have to arrange books, catalogues, clippings and other printed matter. An explanation of the method of using the index is given.



Grab for Handling Rock.

Now that engineering positions in city, state and federal public service are generally obtained by civil service examination, it is desirable that intending candidates should have some general indication of the class of questions likely to be given to them on their examination papers. While experience and general character are given considerable weight in determining the rating of candidates, the results of the examinations are important because in a good many cases no candidate can receive an appointment unless his examination papers are good enough to give him a certain percentage standing. Even if he has devoted his life to a specialty and has gained a high standing in it, he must pass a certain percentage in his written papers. As a guide to the class of questions which are asked, Messrs. Myron H. Lewis and Milton Kempner have compiled a volume, "Manual of Examinations for Engineering Positions," giving examination papers set for examinations of candidates for positions as axemen, chainmen, rodmen, levelers, transitmen, assistant engineers, draftsmen and inspectors in the classified civil list of New York City, and for positions of a somewhat similar nature with the federal departments and in a number of other cities. The value of the book lies in the answers given to the questions, so as to indicate about what kind of replies are expected from candidates. It often happens that candidates start out to write a treatise about the first question and so do not have time to cover their papers as they should; the book indicates what may be considered proper fullness in answers to such a great variety of questions that it should be particularly helpful to those who have not taken such examinations before. (New York, Engineering News Publishing Co., $5.)

A well-written volume characterized more by a good balancing of contents than any decidedly original statements is "Long-Distance Electric Power Transmission," by Mr. Rollin W. Hutchinson, Jr. The title is somewhat misleading, for nearly a third of the pages are devoted to water power development exclusively, and the evident purpose of the author is to explain all the parts of works for utilizing water power electrically. The first chapter gives an explanation of the elementary laws of hydraulics and states how the discharge of streams is gauged, and the next one is on dams, canals, pipes and flumes. The third chapter is on turbines, impulse wheels and governors, and contains a large amount of information in a small space. The second part of the book begins with the fourth chapter, on generators, switches and protective devices, which describes the electric apparatus in the power station. Chapter five explains the laws governing the electric transmission of energy, and the next chapter the apparatus and construction of transmission lines. Chapter seven is on transformers, chapter eight on synchronous and induction motors, and chapter nine on converters. The next chapter is on the practical design and cost of such plants and their limitations, and the last chapter describes the Snoqualmie Falls, Canyon Ferry, Colgate and Spier Falls plants. The author's method is to explain principles first and then their applications, and the many illustrations in the text add materially to the value of the book. The author's experience in the design and construction of hydro-electric systems has enabled him to combine theory and practice in a happy manner and to produce a decidedly reliable and readable book. (New York, D. Van Nostrand Co., $3.)

An Unusual Quay 1,080 ft. long has been constructed by the Great Eastern Ry. at Parkeston, England, from the plans of Mr. John Wilson. It is carried by about 450 reinforced concrete piles driven through a 15-ft. bed of gravel into a stratum of hard clay lying about 44 ft. below the quay level. At its back about 870 reinforced concrete tongue-and-groove sheet piles are used to hold the filling of an area that is being reclaimed. Above this sheeting a curtain wall will be built up to deck level, and a horizontal platform will extend landwards to utilize the weight of a part of the filling as a counterbalance to a considerable proportion of the horizontal thrust of the earth against the quay. Along the harbor front, the quay will be supported on massive reinforced concrete piers. The superstructure forms a continuous monolith of columns, walings, bracings, beams and decking, all the reinforced concrete work being designed on the Hennebique system. The deck will carry tracks for cranes and cars.

Letters to the Editor.

ANCIENT RESERVOIRS IN ALEXANDRIA, EGYPT.

SIR: I have pleasure in forwarding you plans of underground storage reservoirs for water constructed in Alexandria over two thousand years ago. Up to the present there have been ninety-eight discovered in the city, and all have been apparently used for storage of water.

It will be interesting to engineers to see how nearly the construction carried out in ancient times tallies with that of modern practice. The excellent state of preservation of the reservoirs demonstrates the care the Egyptian engineers took in the selection of their materials and in their supervision of the work.

Yours very truly, D. E. LLOYD DAVIES,
Alexandria, April 12. Municipal Engineer.

THE REINFORCED CONCRETE COLUMN.

SIR: The accidents that have recently happened to buildings of reinforced concrete during construction make it manifest that there is need of a careful consideration of all features of such work, and in the following note the writer proposes to call attention to the design of columns. The hooped column is one which is essentially a concrete type, and the computations employed in designing in it are based on an assumed value of the compressive resistance of concrete ranging from 350 to 500 lb. per square inch, when building laws fix such matters, to 1,000 lb., or considerably more when the design is made in the office of economical contractors. In view of the questionable results of mixing and placing concrete in the manner which everybody has witnessed from time to time, it is evident that the theoretical bearing capacity proportioned in this manner is affected seriously by the personal equation of the workmen, although the extent of this influence cannot be readily detected. Hence in columns of this type the personal equation enters very largely, and it is accordingly desirable to have a type which is more uniformly certain to possess the strength desired by the designer of the work. A block of wood, a batch of concrete mixed with a few sacks of stale cement, the bursting of a column form enough to allow the liquid mortar to drain off, an indifferent foreman who feels he is underpaid, and other factors all make it desirable that columns in particular should be designed in accordance with some method that will make their safety more certain than is possible with the hooped type.

The writer believes that in a correctly designed column of reinforced concrete, the individual floor loads will be transferred as described below to the concrete surrounding a series of plain round bars, of which the disposition and section are determined in the ordinary way for standard steel columns, by the moment of inertia, the radius of gyration, the ratio of the length to the radius and four times the safety factor of the load. To illustrate the functions of these compressive bars, we may assume that between floors a sectional portion of the concrete in the column is removed, leaving only enough of it to receive the floor loads by means of the beams. The area of the surface of these bars which must thus remain covered with concrete is equal to the floor load divided by 80, the co-efficient for adhesion. For example, a floor load of 100,000 lb. would require 1,250 sq. in. of adhesion area, and can be taken care of by eight bars 2⅜ in. in diameter, covered with concrete for a length of 21 in.

In case the buckling of the exposed compression bars is provided against, the rest of the column made in this way could be anything the personal equation of the workmen made it throughout its length, without any probability of a subsequent coroner's investigation. Failure in such a column can never be attributed to the early removal of forms, nor be thrown on an unsuspecting foreman buried in the ruins, but the personal equation in this case rests with those responsible for the design.

It would not be economy, of course, to neglect the concrete in a column entirely, for it is capable of carrying a portion of the load. In practice the value of the compressive resistance of concrete may be deducted from the total load imposed upon the steel bars, and their section may thus be reduced. The individual load transmitted to and taken up by the compression bars is carried down to a cast-iron plate or base of appropriate design, the bottom area of which is equal to the total of all the floor loads plus the dead loads of the columns and casting, divided by 500, the co-efficent for good concrete in compression. The compression bars should be held in their respective places by the concrete itself, acting as a lacing, and also by 3/16-in. wire ties of such shape and disposition that any deflection or buckling effect is prevented, and the additional advantage is gained of increasing the radius of gyration in the upright post. The centering of these ties becomes of considerable importance. For example, starting with eight round bars of 2⅜-in. diameter at the bottom of a column and ending at the top in four ¾-in. round bars, the efficiency of these rods as compression members would be greatest at the base plate and nothing near the top. Hence we begin gradually to relieve the bars of a portion of their burden and transfer an equal amount of it to the concrete in the column by means of the ties, until near the top the stress is practically all on the concrete and none on the bars. In order to permit this simple apportionment of stresses the ties are placed closer and closer together as the column is built up from the bottom, and near the top they should be on about 3-in. centers, assuming their full functions like hoops in a Considère column.

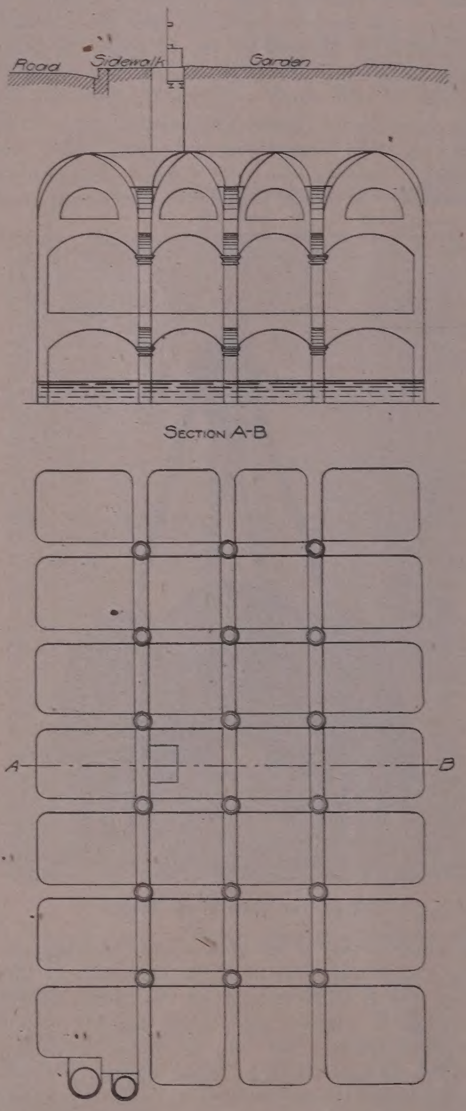


Diagram of Ancient Alexandria Reservoir.

Perhaps the first building of some size where this method of construction has been carried out is the H. D. Hostetter Warehouse in Pittsburg, designed by the writer. It is a 14-story, reinforced-concrete structure, having columns 26 in. square in the basement and supporting a maximum load of 616 tons. If these columns were constructed by the ordinary method and proportioned for a load of 500 lb. per square inch on the concrete they would have to be 50 in. square at the bottom.

Yours truly, CHARLES F. WALTHERS.
Wabash Bldg., Pittsburg, April 13.

EARTH IN RESERVOIR EMBANKMENTS.

SIR: The slip of a portion of one of the dykes of the Wachusett reservoir (see Eng. Record, April 27) is of considerable interest in view of the work which is planned in connection with several large contemplated enterprises. A study of several notable landslides, and especially the experimental investigation of the subject of the coefficient of internal sliding friction in earth (see paper on "Lateral Earth Pressures and Related Phenomena" before American Society of Civil Engineers and several editorials in The Engineering Record thereon), has convinced the writer that in many embankments, both natural and artificial, the structures are in barely stable equilibrium as regards shearing or sliding or squeezing of certain strata. In the description of the slip above mentioned are enumerated several possible so-called causes. It seems to the writer that the real trouble was due to the existence of a stratum or mass of material in the dyke which possessed a low internal friction factor. With this inherent condition, all the conjectures—porous material when saturated, embankment dumped so as to become stratified in wrong direction, excessive weight of riprap, natural bed became slippery or was compressed enough to start motion—relate to facts which are incident to, or strongly aggravate, the tendency to slide.

It has been suggested as a remedy, that "where material of a pervious sandy nature is used for facing a reservoir embankment, it must be placed on a slope considerably flatter than that which it naturally assumes when dumped from a height." The writer feels that this is dodging the real issue, and, besides, he has known of slips, or rather squeezings out of low strata, thereby causing slips, when the top surface was horizontal and the lower strata had actually to be forced upward. In this day of the scientific testing of almost everything, when the permeability of embankment material is carefully investigated, it would seem that an additional series of experiments should be made in each important case covering the internal friction coefficient of the same material under widely varying percentages of saturation. Only then can an embankment design be intelligently prepared. Clay, for instance, is very impervious, but would be exceedingly dangerous if placed in certain portions of an embankment. On the other hand, the writer has seen the finest sand in natural subaqueous embankment stand for years at an angle of 45 deg., showing conclusively that the angle of surface slope and the perviousness of the material are only very distantly related to the real stability of embankments.

E. P. GOODRICH.
New York, April 29.